

WATER QUALITY
AND
POLLUTION CONTROL
IN MICHIGAN
2020 SECTIONS 303(d), 305(b), AND 314
INTEGRATED REPORT



Michigan Department of Environment, Great Lakes, and Energy
Water Resources Division
September 2020

This Integrated Report is available electronically on the Michigan Department of Environment, Great Lakes, and Energy (EGLE), Water Resources Division, Web site at <http://www.michigan.gov/deqwater> under Lakes & Streams, Surface Water, Assessment of Michigan Waters, Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report.

ACKNOWLEDGEMENTS

Great appreciation is extended to contributing staff members of various EGLE divisions and the Great Lakes Environmental Center for their hard work and assistance in the development of this Integrated Report.

The title page and Chapters 4 and 9 heading images were provided by Elizabeth Stieber, EGLE; the Chapter 1 heading image was provided by Dawn Roush, EGLE; the Chapters 2, 3, and 6 heading images were provided by Kevin Goodwin, EGLE; the Chapter 5 heading image was provided by Marcy Knoll Wilmes, EGLE; the Chapter 7 heading image was provided by Ryan Baldwin, EGLE; and the Chapters 2 and 8 heading images were provided by Aaron Parker, EGLE.

Report Compiled by: Kevin Goodwin, Jason Smith
Surface Water Assessment Section
Water Resources Division

TABLE OF CONTENTS

ACKNOWLEDGEMENTS.....	i
LIST OF TABLES.....	iv
LIST OF FIGURES	v
EXECUTIVE SUMMARY	viii
CHAPTER 1	1
INTRODUCTION	1
1.1 PURPOSE.....	1
1.2 MICHIGAN’S WATERS	2
1.2.1 Great Lakes, Bays, Connecting Channels, and Lake St. Clair.....	3
1.2.2 Inland Lakes and Reservoirs	4
1.2.3 Rivers	10
1.2.4 Wetlands	11
1.2.5 Water Protection Activities	12
CHAPTER 2	13
WATER QUALITY MONITORING	13
CHAPTER 3	16
ASSESSMENT METHODOLOGY	16
3.1 INTRODUCTION	16
3.2 DATA AND INFORMATION USED TO DETERMINE DESIGNATED USE SUPPORT.....	16
3.3 DETERMINATION OF DESIGNATED USE SUPPORT.....	18
3.4 DESIGNATED USES: AGRICULTURE, NAVIGATION, AND INDUSTRIAL WATER SUPPLY	19
3.4.1 Assessment Type: No Specific Indicator or Assessment Method...	19
3.5 DESIGNATED USE: WARMWATER FISHERY AND COLDWATER FISHERY	19
3.5.1 Assessment Type: Physical/Chemical.....	19
3.5.2 Assessment Type: Biological	22
3.6 DESIGNATED USE: OTHER INDIGENOUS AQUATIC LIFE AND WILDLIFE	23
3.6.1 Assessment Type: Physical/Chemical.....	23
3.6.2 Assessment Type: Biological.....	27
3.7 DESIGNATED USE: PARTIAL BODY CONTACT RECREATION AND TOTAL BODY CONTACT.....	30
RECREATION	30
3.7.1 Assessment Type: Pathogen Indicators.....	30
3.7.2 Assessment Type: Physical/Chemical.....	33
3.8 DESIGNATED USE: FISH CONSUMPTION	34
3.8.1 Assessment Type: Physical/Chemical.....	34
3.8.2 Assessment Type: Other Public Health Indicators	35
3.9 DESIGNATED USE: PUBLIC WATER SUPPLY	36
3.9.1 Assessment Type: Physical/Chemical.....	36
3.10 ASSESSMENT UNITS AND DETERMINATION OF GEOGRAPHIC EXTENT	39
3.11 Assessment Unit Assignment to Categories.....	40
3.12 Impairment Cause and Source	43
3.13 Delisting Category 5 Assessment Units	43
3.14 Assessment Methodology Changes	44
CHAPTER 4	45
ASSESSMENT RESULTS: THE GREAT LAKES, BAYS, CONNECTING CHANNELS (ST. MARYS, ST. CLAIR, AND DETROIT RIVERS), AND LAKE ST. CLAIR	45
4.1 TROPHIC STATUS	45
4.2 WATER CHEMISTRY OF THE GREAT LAKES CONNECTING CHANNELS	45
4.3 WATER CHEMISTRY OF SAGINAW BAY AND GRAND TRAVERSE BAY	46
4.4 FISH CONTAMINANTS.....	46
4.5 CONTAMINATED SEDIMENTS	48

4.6	<i>E. COLI</i>	49
4.7	<i>DECAYING ORGANIC MATTER DEPOSITS AND NUTRIENTS</i>	49
4.8	<i>LAKE ERIE SUPPORT SUMMARY</i>	51
CHAPTER 5		53
ASSESSMENT RESULTS:.....		53
INLAND LAKES AND RESERVOIRS		53
5.1	<i>TROPHIC STATUS</i>	53
5.2	<i>FISH CONTAMINANTS</i>	54
5.3	<i>BEACHES</i>	55
5.4	<i>WATER CHEMISTRY</i>	55
CHAPTER 6		56
ASSESSMENT RESULTS: RIVERS		56
6.1	<i>BIOLOGICAL INTEGRITY</i>	56
6.2	<i>WATER CHEMISTRY</i>	56
6.3	<i>FISH CONTAMINANTS</i>	57
6.4	<i>MICROORGANISMS</i>	57
CHAPTER 7		59
ASSESSMENT RESULTS: WETLANDS.....		59
7.1	<i>DESIGNATED USE SUPPORT SUMMARY</i>	59
CHAPTER 8		60
WATER BODIES NOT SUPPORTING DESIGNATED USES AND CWA SECTION 303(D)		
REQUIREMENTS		60
8.1	<i>INTRODUCTION</i>	60
8.2	<i>IMPAIRMENT CAUSE AND SOURCE</i>	60
8.3	<i>TMDL DEVELOPMENT</i>	60
8.3.1	<i>The TMDL Process</i>	60
8.3.2	<i>TMDLs Completed</i>	61
8.3.3	<i>TMDL Schedule per Michigan's 2016-2022 Prioritization Framework for the Long-Term Vision for Assessment, Restoration, and Protection Under the Clean Water Act Section 303(d) Program</i>	61
8.3.4	<i>Changes to the Section 303(d) List</i>	63
PUBLIC PARTICIPATION IN THE IR.....		64
9.1	<i>INTRODUCTION</i>	64
9.2	<i>REQUEST FOR DATA</i>	64
9.3	<i>PUBLIC NOTICE OF DRAFT ASSESSMENT METHODOLOGY</i>	65
9.4	<i>PUBLIC NOTICE OF THE DRAFT IR</i>	68
Literature Cited		70

LIST OF TABLES

Table 1.1	Michigan Atlas	3
Table 1.2	Jurisdictional Control of the Four Great Lakes Bordered by Michigan	4
Table 1.3	Michigan's Public Access Lakes and Cisco Lakes by County.....	6
Table 3.1	Carlson's TSI Equations.....	26
Table 3.2	Michigan Inland Lakes Trophic Status Classification Criteria	26
Table 3.3	Examples of Assessment Unit Assignment to Categories Using a Multiple Category System with Three Designated Uses	40
Table 4.1	Trophic Status of the Great Lakes Bordering Michigan	43
Table 5.1	Trophic Status Summary of Michigan's Public Access Lakes.....	47
Table 9.1	Summary of outside data received and their use in the 2020 IR.....	60

LIST OF FIGURES

Figure 1.1	Ecoregions of Michigan.....	10
Figure 2.1	Five-Year Rotating Watershed Cycle	15
Figure 3.1a.	Determination of other indigenous aquatic life and wildlife and warmwater/coldwater fishery designated uses support using water column toxic substance concentration for non-BCCs.....	24
Figure 3.1b.	Determination of other indigenous aquatic life and wildlife designated use support using water column toxic substance concentration for BCCs	24
Figure 3.2.	Determination of other indigenous aquatic life and wildlife designated use support using sediment toxicity	28
Figure 3.3a.	Determination of partial body contact designated use support using ambient <i>E. coli</i> water column concentration. See Section 3.7.1.1 for additional details..	30
Figure 3.3b.	Determination of total body contact designated use support using ambient <i>E. coli</i> water column concentration. See Section 3.7.1.1 for additional details..	31
Figure 3.4.	Determination of fish consumption designated use support using water column mercury concentration	32
Figure 3.5.	Determination of the Public Water Supply designated use support using WQS or MCLs	35
Figure 4.1.	Existing and Draft Fish Consumption Impairments based on PFOS in Fish Tissue data.....	47
Figure 4.2.	Proposed area (outlined in red) for impairment based on stamp sands migration in the vicinity of Gay, Michigan and the Buffalo Reef (outlined in blue).....	48

LIST OF APPENDICES

- Appendix A1. Maps of 8-digit and 12-digit HUCs in Michigan-Lower Peninsula.
- Appendix A2. Maps of 8-digit and 12-digit HUCs in Michigan-Upper Peninsula.
- Appendix B. Comprehensive list of assessment unit designated use support, 305(b) list.
- Appendix C. Assessment Units not supporting designated uses, 303(d) list.
- Appendix D1. Section 303(d) list modifications-delistings.
- Appendix D2. Section 303(d) list modifications-new listings.
- Appendix E. Public comments.

Due to the extensive number of pages contained in these documents, all appendices are available electronically at <http://www.michigan.gov/deqwater> under Lakes & Streams, Surface Water, Assessment of Michigan Waters, Water Quality and Pollution Control in Michigan Sections 303(d), 305(b), and 314 Integrated Report.

LIST OF ACRONYMS

AIS	Aquatic Invasive Species
AOC	Area of Concern
ATTAINS	Assessment, Total Maximum Daily Load Tracking and Implementation System
BCC	Bioaccumulative Chemicals of Concern
BPJ	Best Professional Judgment
BUI	Beneficial Use Impairment
CAZ	Critical Assessment Zone
CSO	Combined Sewer Overflow
CWA	Clean Water Act
DDT	Dichlorodiphenyltrichloroethane
EGLE	Michigan Department of Environment, Great Lakes, and Energy
GIS	Geographic Information System
HCV	Human Cancer Value
HNV	Human Noncancer Value
HUC	Hydrologic Unit Codes
IR	Integrated Report
LHD	Local Health Department
MCL	Maximum Contaminant Level
MDARD	Michigan Department of Agriculture & Rural Development
MDHHS	Michigan Department of Health and Human Services
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
NHD	National Hydrography Dataset
ng/L	Nanograms per liter
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NREPA	Natural Resources and Environmental Protection Act
P51	Procedure 51
PBB	Polybrominated Biphenyl
PCB	Polychlorinated Biphenyl
PFAS	Per- and polyfluoroalkyl substances
PFOS	Perfluorooctane Sulfonate
TMDL	Total Maximum Daily Load
TSI	Trophic Status Index
USEPA	United States Environmental Protection Agency
ug/L	Micrograms per liter
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
WCMP	Water Chemistry Monitoring Program
WQS	Water Quality Standards
WRD	Water Resources Division

EXECUTIVE SUMMARY

The federal Water Pollution Control Act (PL 92-500), also known as the Clean Water Act (CWA), requires states to provide the United States Environmental Protection Agency (USEPA) with an assessment of the quality of their waters (Section 305[b]), a list of waters that do not support their designated uses or attain Water Quality Standards (WQS) and require the development of Total Maximum Daily Loads (TMDLs) (Section 303[d]), and an assessment of status and trends of publicly owned lakes (Section 314). Similar to the 2018 reporting cycle, the Michigan Department of Environment, Great Lakes, and Energy (EGLE) (formerly the Michigan Department of Environmental Quality [MDEQ]) is fulfilling these CWA reporting requirements in 2020 through the submission of an Integrated Report (IR).

A primary objective of this IR is to describe attainment status of Michigan's surface waters relative to the designated uses specified in Michigan's WQS. Michigan's WQS are consistent with the Great Lakes Initiative, establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary framework that guides EGLE's water quality monitoring/assessment and water protection activities. To describe the attainment status of surface waters, each water body is placed in at least one of five reporting categories based upon the amount of information known about the water body's water quality status, the degree of designated use support, and the type of impairment preventing designated use support.

This IR includes a description of the scope of Michigan waters covered; an overview of water quality monitoring in Michigan; a description of Michigan's current assessment methodology; brief summaries of monitoring results and designated use support in the Great Lakes (including connecting channels and bays), inland lakes and reservoirs, rivers, and wetlands; information regarding water bodies not supporting designated uses, including water bodies requiring the development of a TMDL (i.e., Section 303[d] listings); and a summary of the public participation process used in the development of this IR.

With the biennial development of each IR, Michigan continues to refine its data management and assessment methodology. Following the assessment data migration during the 2018 IR, this 2020 IR is the first to fully use the USEPA-developed and redesigned Assessment, Total Maximum Daily Load Tracking and Implementation System (ATTAINS) from start to finish in the IR development. ATTAINS was created as the singular location for assessment decision storage and output nationwide to be implemented for the 2018 IR cycle by all states and tribes.

This shift to using the ATTAINS, when paired with the recent release of the redesigned "How's My Waterway" Web site (June 2020; <https://mywaterway.epa.gov/>), gives broad access to the nation's water quality information at many scales and assessment decisions in a user-friendly platform geared toward the lay-person, but with details and data that technical experts will also find helpful. As such, use of past resources such as the Michigan Surface Water Information Management System (MiSWIMS) to display similar information has been discontinued. Availability of access to Geographic Information System (GIS) data is planned for this 2020 IR cycle as well.

Detailed lists of designated use support are contained in this report (Appendix B). Broadly, many of Michigan's surface waters continue to be impacted by polychlorinated biphenyls (PCB) and mercury and consequently do not support the other indigenous aquatic life and wildlife designated use and/or the fish consumption designated use. Atmospheric deposition is considered to be the major source of these persistent bioaccumulative chemicals. Additionally, Per- and polyfluoroalkyl substances (PFAS) comprise an emerging group of contaminants that may have broad impacts on water quality. The recent significant expansion in PFAS monitoring

in Michigan provided data that, once received and quality checked, were considered in this 2020 IR. Excluding widespread PCBs and mercury-related impairments, physical/chemical and biological assessments of inland lakes and rivers indicate designated uses are supported in a majority of water bodies.

CHAPTER 1 INTRODUCTION

1.1 Purpose

The federal Water Pollution Control Act (PL 92-500), also known as the CWA, requires states to provide the USEPA with an assessment of the quality of their waters (Section 305[b]), a list of waters that do not support their designated uses or attain WQS and require the development of TMDLs (Section 303[d]), and an assessment of status and trends of publicly owned lakes (Section 314).

Like the 2018 reporting cycle, EGLE is fulfilling these CWA reporting requirements in 2020 through the submission of an IR. Where possible, Michigan's 2020 IR was developed consistent with the USEPA's "Guidance for 2006 Assessment, Listing and Reporting Requirements Pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act" and supplemental guidance information for 2008-2018 IRs prepared by the USEPA.

A primary objective of this IR is to describe attainment status of Michigan's surface waters relative to the designated uses specified in Michigan's WQS (available at https://www.michigan.gov/documents/deq/wrd-rules-part4_521508_7.pdf). Michigan's Part 4 Rules, WQS, are promulgated under Part 31, Water Resources Protection, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended (NREPA). Michigan's WQS are consistent with the Great Lakes Initiative, establish minimum water quality requirements by which the waters of the state are to be managed, and provide the primary regulatory framework that guides EGLE's water quality monitoring/assessment and water protection activities. To describe the attainment status of surface waters, each water body is placed in at least one of five reporting categories (see Section 4.11) based upon the amount of information known about the water body's water quality status, the degree of designated use support, and the type of impairment preventing designated use support. Additionally, the attainment status information described within this IR is used to help inform some of the outcomes associated with various goals identified within the Water Resources Division's (WRD) Measures of Success. The Measures of Success are used to define the expected outcomes of water resource programs geared toward having clean and safe water (http://www.michigan.gov/egle/0,1607,7-135-3306_28610---,00.html).

Similar to previous IRs, trends in designated use support are not discussed in this IR. Due to data management changes over time, and assessment methodology changes cycle-to-cycle, designated use support summaries are not directly comparable to previous IRs. Analysis of designated use support trends based on information presented in this and previous reports (e.g., change in number of river miles supporting designated uses) would be misleading.



The remainder of this chapter includes a description of the scope of Michigan waters covered in this IR. Chapter 3 details Michigan's current assessment methodology. Chapters 4, 5, 6, and 7 provide summaries of monitoring results and designated use support in the Great Lakes (including connecting channels and bays), inland lakes, rivers, and wetlands, respectively. Chapter 8 addresses all water body types not supporting designated uses, including water bodies requiring the development of a TMDL [i.e., Section 303(d) listings]. Chapter 9 includes information regarding the public participation process in the development of this IR.

Data Management and Output Updates

This 2020 IR cycle continues the significant changes started in the 2018 IR cycle related to recording, storing, and communicating information surrounding assessment decisions. This shift to the USEPA-developed ATAINS as the singular location for assessment decision storage and output nationwide achieves more efficient data transfer between the state and the USEPA; establishes a more consistent system for states and authorized tribes to store, exchange, and retain assessment information; and ultimately provides greater public access to information as part of the redesigned How's My Waterway Web site released in June, 2020, <https://mywaterway.epa.gov>.

Importantly, the appendices which comprise the Section 305(b) and 303(d) lists are available (Appendices B and C, respectively), as are explicit lists of impairment delistings and new listings (Appendices, D1 and D2, respectively).

As in past cycles, Michigan's system uses a 12-digit hydrologic unit code (HUC)-based naming convention and the National Hydrography Dataset (NHD) to georeferenced records.

1.2 Michigan's Waters

Michigan is blessed with a wealth of surface water resources, including Great Lakes and their connecting channels, inland lakes, rivers, and wetlands (Table 1.1). Most of Michigan also has an abundant supply of high-quality groundwater.

In general, the open waters of the Great Lakes have good to excellent water quality. The inland waters of Michigan's Upper Peninsula and the northern half of the Lower Peninsula support diverse aquatic communities and are commonly found to have good to excellent water quality. Many lakes and rivers in this mostly forested area of the state support coldwater fish populations. Lakes and rivers in the southern half of Michigan's Lower Peninsula generally have good water quality and support warmwater biological communities as well as some coldwater fish populations. The southern portion of the state contains Michigan's major urban areas with much of the rural land in agricultural production. Many of Michigan's rivers and lakes receive direct discharge of treated effluent from municipal and industrial sources as well as runoff from urbanized areas, construction sites, and agricultural areas. Sedimentation, nutrient enrichment, and toxic pollutant loading are problems associated with runoff that can impact surface water quality. Surface water quality is generally showing improvement where programs are in place to correct problems and restore water quality.

Table 1.1 Michigan Atlas (all values are approximations).

Topic	Number	Area	Length	Source
State population	9.9 Million			United States Census Bureau 2010 Estimate
State surface area		96,760 mi²		Sommers, 1977
Great Lakes, Great Lakes bays, and Lake St. Clair		42,167 mi² (~45% of total Great Lakes area)	3,049 mi shoreline	USGS NHD (1:24,000 scale)
Inland lakes and reservoirs with surface area ≥ 0.1 acre	46,000	872,109 acres		USGS NHD (1:24,000 scale)
Rivers and streams (including connecting channels)			76,439 mi	USGS NHD (1:24,000 scale)
Wetlands		6,465,109 acres		USFWS National Wetland Inventory

1.2.1 Great Lakes, Bays, Connecting Channels, and Lake St. Clair

The Great Lakes contain 20 percent of the world's fresh surface water and are a unique natural resource. The protection of the Great Lakes is shared by the United States and Canadian federal governments; the states of Minnesota, Wisconsin, Michigan, Illinois, Indiana, Ohio, Pennsylvania, and New York; and the Canadian Provinces of Ontario and Quebec. Various Native American tribal organizations are also stakeholders and play a role in protecting Great Lakes water quality.

Michigan lies almost entirely within the watersheds of Lakes Superior, Michigan, Huron, and Erie (Table 1.2). The state maintains jurisdiction over approximately 45 percent (by surface area) of the 4 bordering Great Lakes (38,865 of a total area of 86,910 square miles) and 3,049 miles of Great Lakes shoreline. Significant Great Lakes bays include Grand Traverse Bay and Saginaw Bay. In this IR, the St. Marys, St. Clair, and Detroit Rivers (connecting channels) and Lake St. Clair are generally discussed in the Great Lakes Chapter (see Chapter 4). The term "connecting channels" used in this report is slightly different than the term "connecting waters" defined in Michigan's WQS. In this IR, the Keweenaw waterway (i.e., the Portage Lake ship canal, Portage Lake, Portage River, etc.) is reported as river miles and inland lakes. Michigan's WQS include the Keweenaw waterway in the "connecting waters" definition.

Generally, the open waters of the upper Great Lakes (Superior, Michigan, and Huron) have excellent water quality. Exceptions include a few impaired locations restricted to nearshore zones influenced by large, densely populated, and heavily industrialized areas. Great Lakes water quality has benefited from pollutant control and remedial efforts in tributaries. These activities have reduced the discharge of conventional and toxic pollutants, including nutrients, persistent organic compounds, metals, and oils.

Table 1.2 Jurisdictional control of the four Great Lakes bordered by Michigan.

	Canadian* (miles ²)	United States* (miles ²)	Michigan† (miles ²)	Total* (miles ²)
Lake Superior	11,100	20,600	16,400	31,700
Lake Michigan	---	22,300	13,250	22,300
Lake Huron	13,900	9,100	9,100	23,000
Lake Erie	4,930	4,980	115	9,910
Total	29,930	56,980	38,865	86,910

*Strum, 2000; †United States Census Bureau 2002 estimate

Aquatic Invasive Species (AIS) continue to have dramatic indirect and direct effects on the Great Lakes. AIS are responsible for increases in water clarity, loss of organisms and biodiversity, disruption of food webs, and impacts on economically important fish species (International Association for Great Lakes Research, 2002). Emerging research also shows that AIS cause changes in nutrient cycling and availability and may contribute to increased plant and algae growth in many nearshore areas, such as Saginaw Bay and the western basin of Lake Erie.

The Great Lakes have problems with selected persistent bioaccumulative chemicals. Fish consumption advisories in the Great Lakes serve as reminders that certain pollutants, such as PCBs, chlordane, dioxins, and mercury remain elevated in the water column and fish tissue. The use of PCBs and dichlorodiphenyltrichloroethane (DDT) was banned in the 1970s and concentrations of these chemicals in Great Lakes fish have declined; however, concentrations in some species still require consumption advisories. Atmospheric deposition, tributary loadings, and the dynamic exchange and cycling between air, water, and sediment within the Great Lakes basins are the key factors influencing contaminant levels in Great Lakes fish.

1.2.2 Inland Lakes and Reservoirs

Michigan has approximately 46,000 inland lakes (including lakes, ponds, and river impoundments) with a surface area of at least one-tenth of an acre or greater. Lakes with the largest surface area include Houghton (Roscommon County), Torch (Antrim and Kalkaska Counties), Charlevoix (Charlevoix County), Burt (Cheboygan County), Mullett (Cheboygan County), Gogebic (Gogebic and Ontonagon Counties), Manistique (Luce and Mackinac Counties), Black (Cheboygan and Presque Isle Counties), Crystal (Benzie County), Portage (Houghton County), and Higgins (Crawford and Roscommon Counties).

Michigan has 730 inland lakes that are deemed “public access lakes” (Table 1.3). The list of public access lakes includes lakes with a public boat launch and a lake surface area of at least 50 acres as well as a few recreationally important small lakes (less than 50 acres) that have public boat launches. There are 345 public access lakes located in the southern Lower Peninsula, 219 in the northern Lower Peninsula, and 166 in the Upper Peninsula. The average public access lake size is 341 acres in the southern Lower Peninsula, 1,342 acres in the northern Lower Peninsula, and 731 acres in the Upper Peninsula.

Michigan has 156 inland lakes that are deemed “cisco lakes” (Table 1.3). The cisco (*Coregonus artedii*) is a member of a trout and salmon (Salmonidae) subfamily that usually occupies the cooler and deeper niches of high-quality freshwater inland lakes and many parts of the Great Lakes. In North America, cisco can be found from Alaska to New England. Ciscos are, or were, present in at least 156 lakes in 41 Michigan counties ranging from the Indiana border to Keweenaw County in the Upper Peninsula. The cisco is currently identified as a state

threatened species pursuant to the NREPA. Ciscos require relatively deep inland lakes with cool, well-oxygenated waters. During summer stratification, cisco are rarely found in waters above 20°C or at dissolved oxygen concentrations less than 3.0 parts per million. This species is very sensitive to habitat degradation and has been extirpated from lakes where these minimum thermal and dissolved oxygen conditions are not met. In 2003, the Michigan Department of Natural Resources (MDNR) initiated a study to assess the status of the cisco populations in Michigan. The intent of this ongoing study is to identify inland lakes in which populations are extant and increase awareness of this species so that protective Best Management Practices are promoted.

Table 1.3. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

ALCONA Alcona Dam Pond Brownlee Cedar Crooked Hubbard* Jewell North Vaughn ALGER AuTrain Basin AuTrain Lake Deer† Fish Grand Sable Kingston Nawakwa ALLEGAN Allegan Baseline Big Duck Eagle Green* Hutchins Kalamazoo Lower Scott Miner Osterhout Selkirk Swan Swan Creek Pond ALPENA Beaver* Fletcher Pond ANTRIM Bellaire* Benway Birch Clam Elk* Ellsworth Intermediate* Lake of the Woods St. Clair Torch* Wilson BARAGA Beaufort Big Keewaydin King Parent Prickett Dam Ruth Vermilac	BARRY Baker Barlow† Big Cedar† Bristol Carter Chief Noonday Clear Cloverdale Crooked Deep Duncan Fine Fish* Gun Jordan Leach Lime† Little Cedar† Long (Hope Twp) Long (Johnstown Twp)* Long (Yankee Springs Twp) Lower Crooked Middle Payne Pine Thornapple BENZIE Ann* Betsie Crystal* Herendeene Little Platte Lower Herring Pearl Platte Stevens Turtle Upper Herring BERRIEN Paw Paw BRANCH Archer* Bartholomew† Cary Coldwater* Craig East Long* George Gilead Kenyon Lavine Marble* Matteson Morrison North Oliverda Randall Rose (Lake of the Woods) Silver South Union	CALHOUN Duck Goguac Homer Lane Lee Nottawa Prairie Upper Brace Wabascon Warner's Winnipeg CASS Baldwin* Belas Birch* Bunker† Chain† Christiana Curtis† Day† Dewey Diamond Donnell* Driskels Fish Harwood* Hemlock Indiana† Juno/Painter Kirk* Lewis† Lime† Magician Mill North Twin Paradise Round† Shavehead* South Twin Stone Tharp† CHARLEVOIX Charlevoix* Deer Hoffman Six Mile Susan Thumb Walloon* CHEBOYGAN Black Burt* Douglas† Lancaster Long Mullett* Silver Twin Central† Twin North† Twin South †	CHIPPEWA Caribou Carp Frenchmans Hulbert† Monacle* Shelldrake Impoundment CLARE Arnold Big Long Budd Cranberry Crooked Five George Lily Little Long Mud Perch Shingle Silver Windover CLINTON Ovid Park CRAWFORD Jones K.P. Margrethe Section One Shupac DELTA Boney Falls Camp 7 Corner Dana Pole Creek Lake Round Skeels DICKINSON Antoine Bass Carney Edey Hamilton Louise† Mary* Norway Pickeral Rock Sawyer Silver Six Mile EATON Narrow Saubee†
--	---	---	---

Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

EMMET	GRAND TRAVERSE	IOSCO	JACKSON
Crooked	Arbutus	Floyd	Brown†
Larks	Bass	Foote Dam Pond	Center
Paradise	Bass	Indian	Clark
Pickeral	Boardman	Londo	Crispell
Round	Bridge†	Long	Gilletts
	Brown Bridge Pond	Loon*	Grass
GENESEE	Cedar	Loud Dam Pond	Pleasant
C.S. Mott Impoundment	Cedar Hedge*	Round	Portage
Fenton	Dubonnet	Sand	Round
Holloway Reservoir	Duck*	Tawas	South Lime
Kearsley Reservoir	Fife	VanEtten	Swain's*
Lobdell*	Green*	West Londo	Vandercook*
Ponemah	Long		Vineyard
Thread	Silver	IRON	Wampler's
	Spider	Bass	
GLADWIN		Brule	KALAMAZOO
Lake Four	HILLSDALE	Buck	Austin
Pratt	Baw Beese	Cable	Barton
Secord Impoundment	Bear*	Camp	Crooked†
Wiggins	Bird	Chicagon	Eagle
Wixom Impoundment	Carpenter†	Deer	Eagle
	Cub	Ellen	Gourdneck
GOGEBIC	Diane	Emily	Gull*
Allen	Hemlock*	Fire	Hogsett
Bass	Long (Reading Twp)*	First Fortune	Howard†
Beatons	Long (Stubin Co., IN)	Gibson	Indian*
Bobcat	Round	Golden	Long
Chaney	Sand North†	Hagerman	Morrow Pond
Cisco*	Sand Middle†	Hannah Webb	Paw Paw*
Clark*	Sand South†	Indian	Portage (Blue)
Clearwater	Wilson†	Iron	Ruppert
Crooked†		James	Sagmaw†
Dinner	HOUGHTON	Kidney	Sherman
Duck	Bob	Little Smoky	Sugarloaf
Eel	Boston	Long	West
Gogebic*	Emily	Mary	Whitford
Henry Impoundment	Otter*	Michigamme	
Lac Vieux Desert	Pike	Norway	KALKASKA
Loon†	Portage*	Ottawa	Bear
Langford	Rice	Perch	Blue (Big)*
Little Oxbow	Roland	Runkle	Big Guernsey
Lake Pomeroy	Sandy	Smoky*	Cub
Marion	Torch*	Stager	East
McDonald		Stanley	Indian
GOGEBIC cont'd	INGHAM	Sunset	Manistee
Moon	Lansing	Swan	North Blue†
Moosehead		Tamarack	Pickeral
Moraine	IONIA	Tepee	Starvation
Noorwood†	Long	Winslow	Skegmog*
Ormes	Morrison	ISABELLA	Twin (Big)*
Sunday	Sessions	Coldwater*	
Taylor*	Woodard	Halls	
Thousand Island*		Littlefield*	
		Stevenson	

Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

KENT Bass Big Myers Big Pine Island Big Wabasis Camp Campau Campbell Lime Lincoln Murray* Pratt Reeds Ziegenfuss†	LIVINGSTON Appleton* Baseline* Bass† Bennett† Bishop Chemung* Fish† East Crooked* Hiland Limekiln† Ore† Portage† Runyan† Sandy Bottom† Thompson West Crooked* Whitmore Woodland Zukey†	MARQUETTE Anderson Ann† Arfelin Bass Bass Big Shag Dead River Storage Basin Engmans Greenwood Reservoir Horseshoe Independence* Ives† Johnson Little Little Shag Michigamme McClure Storage Reservoir Mountain† Pike Pine† Rush† Silver† Sporley* Squaw Witch Wolf	MISSAUKEE Crooked Goose Long Missaukee Sapphire
KEWEENAW Bailey Desor† Fanny Hoe* Gratiot Lac LaBelle Medora Ritchie† Sargent† Siskiwit† Thayer's	LUCE Bass Bodi Culhane Kaks Muskallonge North Manistique* Perch Pike Twin	MASON Bass Ford Gun Hackert (Crystal) Hamlin Lincoln Pere Marquette Pliness Round	MONTCALM Baldwin Bass Clifford Cowden Crystal Derby Dickerson Halfmoon Horseshoe Little Whitefish Loon Montcalm Mud Muskellunge Nevins Rainbow Rock Tamarack Townline Whitefish Winfield
LAKE Big Bass Big Star Harper Idlewild Little Bass† Paradise Reed Wolf	MACKINAC Brevoort* Little Brevoort Manistique* Milakokia Millicoquins S. Manistique*	MECOSTA Bergess Blue Chippewa Clear Hillsview Horsehead Jehnsen Martiny Mecosta Merrill Pretty Rogers Pond Round School Section Townline	MONTMORENCY Atlanta Avalon* Avery Clear East Twin Ess Gaylanta Grass Lake Fifteen Long* McCormick Muskellunge Rush Sage West Twin
LAPEER Big Fish Davidson Long Minnewanna Nepessing Otter	MACOMB Stony Creek Impoundment	MENOMINEE Long	MUSKEGON Bear Big Blue Duck East Twin Fox Half-Moon Mona Muskegon North White Wolf
LEELANAU Cedar Davis Glen* Lime Little Glen Little Traverse* North Lk Leelanau* School South Lk Leelanau*	MANISTEE Arcadia Bear Canfield Healy Manistee Pine* Portage	MIDLAND Sanford	
LENAWEE Allens Deep Devils Hudson Round Round Sand			

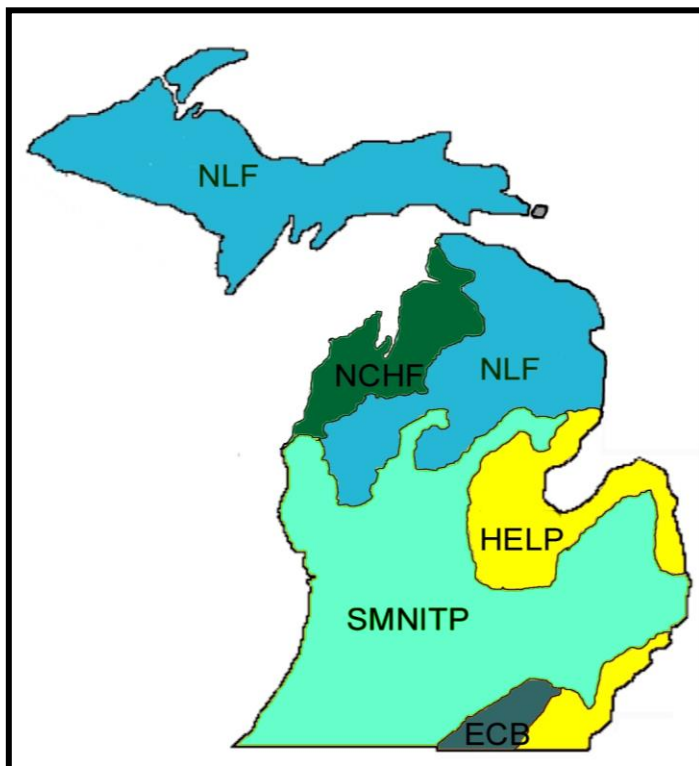
Table 1.3 continued. Michigan's public access and cisco lakes by county. *Indicates that the lake is a public access lake and a cisco lake. †Indicates that the lake is a cisco lake only.

NEWAYGO Baptist Benton Bills Blanch Brooks Croton Dam Pond Crystal Diamond Englewright Fremont Hardy Hess Kimball* Nichols* Pettibone Pickerel* Robinson Sand Woodland OAKLAND Angelus† Big Cass* Cedar Island* Crescent Deer* Dickinson Dunham† Green† Hammond† Heron Kent Lakeville Long Loon* Lotus* Lower Pettibone Maceday* Middle Straits Oakland Orchard* Orion Oxbow† Pontiac Seven Silver† Squaw/Clear Tipsico Townsend† Union* Upper Proud Upper Pettibone† Valley White Wildwood Wolverine	OCEANA Crystal McLaren Pentwater Schoolsection Silver Stony OGEMAW Au Sable Bush Clear DeVoe* George Grousehaven* Hardwood Horseshoe Lake George Peach Rifle Sage Tee ONTONAGON Bond Falls County Line OSCEOLA Big Diamond Hicks Rose Sunrise Todd Wells OSCODA McCollum Mio Dam Pond Tea OTSEGO Big Big Bass Big Bear Bradford Dixon Emerald Heart Manuka Opal Otsego Pickerel Twenty Seven OTTAWA Crockery Macatawa Pigeon Spring	PRESQUE ISLE Big Tomahawk Emma Essau Grand Long Lost May Nettie Shoepac Sunken ROSCOMMON Higgins* Houghton St. Helen SCHOOLCRAFT Boot Colwell Dodge Gemini Gulliver* Indian* Island Kennedy McDonald Petes Ross Snyder ST JOSEPH Big Fish Clear Corey* Crotch Fisher's Klinger* Long Long Palmer Pleasant* Portage Prairie River* Sand Sturgeon Tamarack† Thompson* Three Rivers Impoundment TUSCOLA Caro Reservoir Murphy North	VAN BUREN Ackley Banksons Brandywine Cedar Clear Cora Eagle Eleven Fish Fourteen Gravel Halls Huzzy's Lake of the Woods Maple North Scott Round Rush Saddle School Section Shafer South Scott Three Legged Three Mile Upper Jephtha Upper Reynolds VanAuken Wolf† WASHTENAW Big Portage Blind† Bruin* Cedar Crooked Ford Four Mile Green Half Moon* Joslin Mill Mud North Pickerel† South* Sugar Loaf Winnewanna WAYNE Belleville Newburgh WEXFORD Berry Cadillac Hodenpyl Dam Pond Long Mitchell
---	--	--	---

1.2.3 Rivers

Michigan's rivers can be grouped by the distinct ecoregions through which they flow. Each of the five ecoregions in Michigan consists of areas that exhibit relatively similar geological landform characteristics (Omernik and Gallant, 1988). Factors used to delineate ecoregions include climate, soils, vegetation, land slope, and land use. This framework provides information on the environmental characteristics that tend to occur within each ecoregion. In order by size (largest to smallest area), the five ecoregions in Michigan are Southern Michigan/Northern Indiana Till Plains, Northern Lakes and Forests, North Central Hardwood Forests, Huron-Erie Lake Plains, and Eastern Corn Belt Plains (Figure 1.1).

Rivers in the Northern Lakes and Forests and North Central Hardwood Forests ecoregions tend to support coldwater fish within at least a portion of their systems. These rivers commonly have relatively small watersheds, high relief topography, substantial groundwater inputs, and are naturally low in productivity. Most rivers in the Northern Lakes and Forests ecoregion are perennial, often originating from lakes or wetlands. Although relatively free of sediment, surface waters in this ecoregion often have a characteristic brownish color because of elevated concentrations of dissolved organic material, including tannins and lignins. In the North Central Hardwood Forests ecoregion, river flow is highly variable. Flow is entirely intermittent in some portions of the ecoregion and entirely perennial in other areas. These rivers typically drain soils with much poorer nutrient content than in bordering ecoregions to the south.



SMNITP - Southern Michigan/Northern Indiana Till Plains
NCHF - North Central Hardwood Forests
NLF - Northern Lakes and Forests
HELP - Huron-Erie Lake Plains
ECB - Eastern Corn Belt Plains

Figure 1.1. Ecoregions of Michigan (Level III) (adapted from Omernik and Gallant, 1988).

Rivers in the Southern Michigan/Northern Indiana Till Plains ecoregion are generally of good water quality in the headwaters. This ecoregion is drained predominantly by perennial rivers. Such rivers are typically sluggish and are bordered, often extensively, by wetland tracts. Drainage ditches and channelized rivers have been a common solution to assist drainage of areas that are too wet for settlement and agricultural needs.

Upland features related to poor soil drainage heavily influence the rivers in the Huron-Erie Lake Plains and Eastern Corn Belt Plains ecoregions. Broad and nearly level lake plain is crossed by beach ridges and low moraines, which has resulted in the formation of poorly drained soils. More than half of the rivers in the Huron-Erie Lake Plains ecoregion are intermittent, and river flows are commonly runoff-dependent. In addition to the construction of numerous drainage ditches, the headwaters of many rivers are extensively channelized for quicker drainage and to improve upland field conditions. About half of the rivers in the Eastern Corn Belt Plains ecoregion are perennial and many have been channelized to assist soil drainage. This ecoregion is almost entirely farmland, and river quality is influenced by increased soil and water runoff from agricultural land uses.

1.2.4 Wetlands

About 15 percent of Michigan's land area is wetland. Several inventories of wetlands in Michigan have been undertaken by different agencies. The two most utilized are the Part 303 State Wetland Inventory, and the United States Fish and Wildlife Service (USFWS) National Wetland Inventory. Sources of wetland loss include permitted activities; unpermitted activities (i.e., violations of Section 404 of the CWA and state law); activities that are exempt under state and federal law; the loss of small, isolated wetlands that are not under state or federal jurisdiction; natural processes (e.g., beaver activity); and indirect effects (e.g., alteration of drainage networks due to urbanization). Wetland acreage may increase for some of the same reasons (e.g., changes in drainage pathways). However, most wetland gains are attributed to voluntary wetland restoration projects, pond construction, and mitigation for permitted impacts.

Part 303, Wetlands Protection, of the NREPA requires EGLE to make a preliminary inventory of all wetlands in the state on a county-by-county basis. County wetland inventories are now completed for all 83 counties in the state, and have been made available to the public on the Internet at <http://www.michigan.gov/deqwater> under Wetlands Protection, 'Are there wetlands on my property?'. The county wetland inventories were produced by overlaying data from the following sources: the USFWS National Wetland Inventory maps (1978), Natural Resources Conservation Service soil survey maps, and Michigan Resource Information System land use/land cover maps. County wetland inventories are intended to be used as planning tools that provide potential and approximate locations of wetlands and some information regarding wetland condition, but are not intended to be used to determine the jurisdictional boundaries of wetland areas subject to regulation.

Estimates of wetland losses since European settlement range from 35 percent, based on the Michigan Natural Features Inventory presettlement inventory to 50 percent based on the USFWS Status and Trends reporting. During 2006, EGLE's, Wetlands, Lakes, and Streams Unit, partnered with Ducks Unlimited Great Lakes/Atlantic Regional Office to perform an update to the original National Wetland Inventory dataset that was completed in the late 1970s and early 1980s. The project updated the National Wetland Inventory dataset to the two most recent, statewide, aerial photography flights conducted in the state, that being the 1998 United States Geological Survey (USGS) Digital Ortho Quarter Quads data and the 2005 National Agriculture Imagery Program data. This effort resulted in three distinct temporal wetland inventories for the State from which to draw conclusions and analyze trends. The 1998 inventory shows a total loss of vegetated wetlands of 32,839 acres. The 2005 inventory shows a total loss of vegetated wetlands of 8,096 acres. Subtracting these losses from the original

National Wetland Inventory total wetland acreage yields a total of 6,465,109 acres of wetland remaining in Michigan.

The Michigan Natural Features Inventory published a preliminary assessment entitled, “Wetland Trends in Michigan Since 1800” (Comer, 1996), based on a comparison of original land surveys conducted by the General Land Office from 1816 to 1856 and Michigan Resource Information System land use/land cover maps. This publication includes a county-by-county estimate of historical wetland types and losses since pre-European settlement. In addition, the pre-European settlement maps have been digitized and are available for review in a GIS.

1.2.5 Water Protection Activities

EGLE has a number of programs designed to protect and restore water quality. These programs: establish WQS; provide regulatory oversight for public water supplies; issue permits to regulate the discharge of industrial and municipal wastewaters and to alter wetlands, lakes, streams, and Great Lakes bottomlands; provide technical and financial assistance to reduce pollutant runoff; ensure compliance with state laws; regulate and protect wetlands; and educate the public about water quality issues. More information on Michigan’s water quality protection programs can be found online at <https://www.michigan.gov/deqwater>.

The activities encompassing Michigan’s water quality protection programs are carried out by several EGLE divisions and offices. Full quantification of expenditures is not possible at this time. However, the WRD alone spent approximately \$63.7 million in fiscal year 2018 and \$79.8 million in fiscal year 2019 (the increase reflecting two additional programs reorganized into the WRD: Areas of Concern and Coastal Management) for the implementation of water quality protection, restoration, and monitoring programs. Sources include federal funds, state general funds, Clean Michigan Initiative state bond funds, and fees. These expenditures support EGLE staffing and operating expenses as well as grants and loans to local governments and organizations. A variety of water quality protection activities are implemented through these funds, including regulatory requirements, technical and financial assistance, and education/outreach efforts. These expenditures also leverage substantial local funds and services, since many of the programs and grants have cost-share or match requirements.

The benefits associated with the implementation of these programs are numerous, although it is not possible to accurately quantify the benefits in strictly monetary terms. From a financial perspective, citizens and out-of-state tourists are estimated to have spent \$25.7 billion in 2018 on Michigan tourism, much of that on outdoor sports and recreation that depend on clean water, air, and forests (“2018 Tourism Economic Impact – Statewide.” www.Michigan.org. Web. 29 May 2020.). Popular activities include boating, swimming at Great Lakes and inland beaches, fishing, and hunting. The revenue from these activities far exceed the money spent on water quality protection and monitoring activities each year. Aside from strictly financial considerations, clean water is also essential to protect human health, drinking water quality, biological diversity, and quality of life issues, which attract many businesses and citizens to live and work in Michigan.

CHAPTER 2 WATER QUALITY MONITORING

Environmental monitoring is an essential component of the EGLE mission. Comprehensive water quality monitoring is necessary to improve natural resource management, maintain sustainable ecosystems, and protect public health. Although EGLE is the lead state agency responsible for monitoring, assessing, and managing the state's surface water and groundwater, effective water resource management is best achieved through the formation and implementation of meaningful coalition partnerships with outside entities including other state and federal agencies, Canadian organizations, local governments, tribes, universities, industry, environmental groups, and citizen volunteers. Wherever possible, EGLE strives to organize and direct the resources and energies created by these partnerships through a "watershed approach" to protect the quality and quantity of the state's water resources.



Many EGLE water quality monitoring and water pollution control programs are integrated and implemented according to a 5-year rotating watershed cycle to facilitate effective watershed management. Michigan has 57 major watersheds based on the USGS's 8-digit HUCs. Water quality assessment efforts focus on a subset (approximately 20 percent) of these major watersheds each year (Figure 2.1).

In January 1997, EGLE completed a monitoring report entitled, "A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters" (Strategy) (MDEQ, 1997). It was developed specifically to identify the activities and resources needed to establish a comprehensive, state-of-the-art water quality monitoring program, and has guided Michigan's monitoring program implementation. The Strategy consists of 9 interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity, wildlife contaminants, bathing beaches, inland lake quality and eutrophication, stream flow, and volunteer monitoring. The Strategy specifically identifies 4 monitoring goals:



- Assess the current status and condition of waters of the state and determine whether WQS are being met.
- Measure spatial and temporal water quality trends.
- Evaluate the effectiveness of water quality protection programs.

- Identify new and emerging water quality issues.

The evolving nature of management and program needs, technology, and technical monitoring guidance/science requires continuous evaluation of existing activities to ensure effective, comprehensive monitoring and to identify opportunities for improvement. Program assessment led to an update of the 1997 Strategy in May 2005 and again in January 2017 (MDEQ, 2017) (available at <http://www.michigan.gov/eql> under Water, Lakes and Streams, Water Quality Monitoring, Assessment of Michigan Waters, Monitoring Elements, A Monitoring Overview).

Regarding wetland monitoring, the 4 goals of Michigan's Water Quality Monitoring Strategy are addressed in a separate document entitled, "State of Michigan Wetland Monitoring and Assessment Strategy," updated in 2013. This strategy follows the 3-Tiered Technical Approach – Level 1: Landscape Assessment, Level 2: Rapid Wetland Assessment, and Level 3: Intensive Site Assessment - outlined of the USEPA publication, "Application of Elements of a State Wetland Monitoring and Assessment Program" (USEPA, 2006). The objectives of the wetland monitoring and assessment strategy are:

Objective 1: Complete an inventory of Michigan's wetland resources that provides both fundamental resource information and a baseline for evaluating gains and losses over time.

Objective 2: In order to support state and national no net loss/net gain goals for wetlands, cooperate in updating of National Wetland Inventory maps for use in status and trends reporting.

Objective 3: Assess the effectiveness of Michigan's state-administered Section 404 permit program by tracking authorized impacts and mitigation for those impacts, as well as documented unauthorized impacts and restoration measures.

Objective 4: Apply Landscape Level Functional Wetland Assessment methods to support the protection, management, and restoration of wetlands on a watershed scale.

Objective 5: Evaluate individual wetland sites using the Michigan Rapid Assessment Method to quickly assess the wetland functions and values on an equal scale regardless of ecological type.

Objective 6: Use full scale biological assessment of wetlands for resource management purposes. Develop and document wetland Indices of Biological Integrity and related methods.

Objective 7: In cooperation with other public and private agencies and organizations, provide for the evaluation of Michigan's most outstanding wetland resources, especially Great Lakes coastal wetlands, by supporting the long-term monitoring of wetlands through the Great Lakes Coastal Wetland Consortium and similar cooperative efforts.

Objective 8: Assess statewide wetland quality by establishing a routine wetland monitoring program that parallels other basin-wide water quality monitoring, including the National Wetland Condition Assessment.

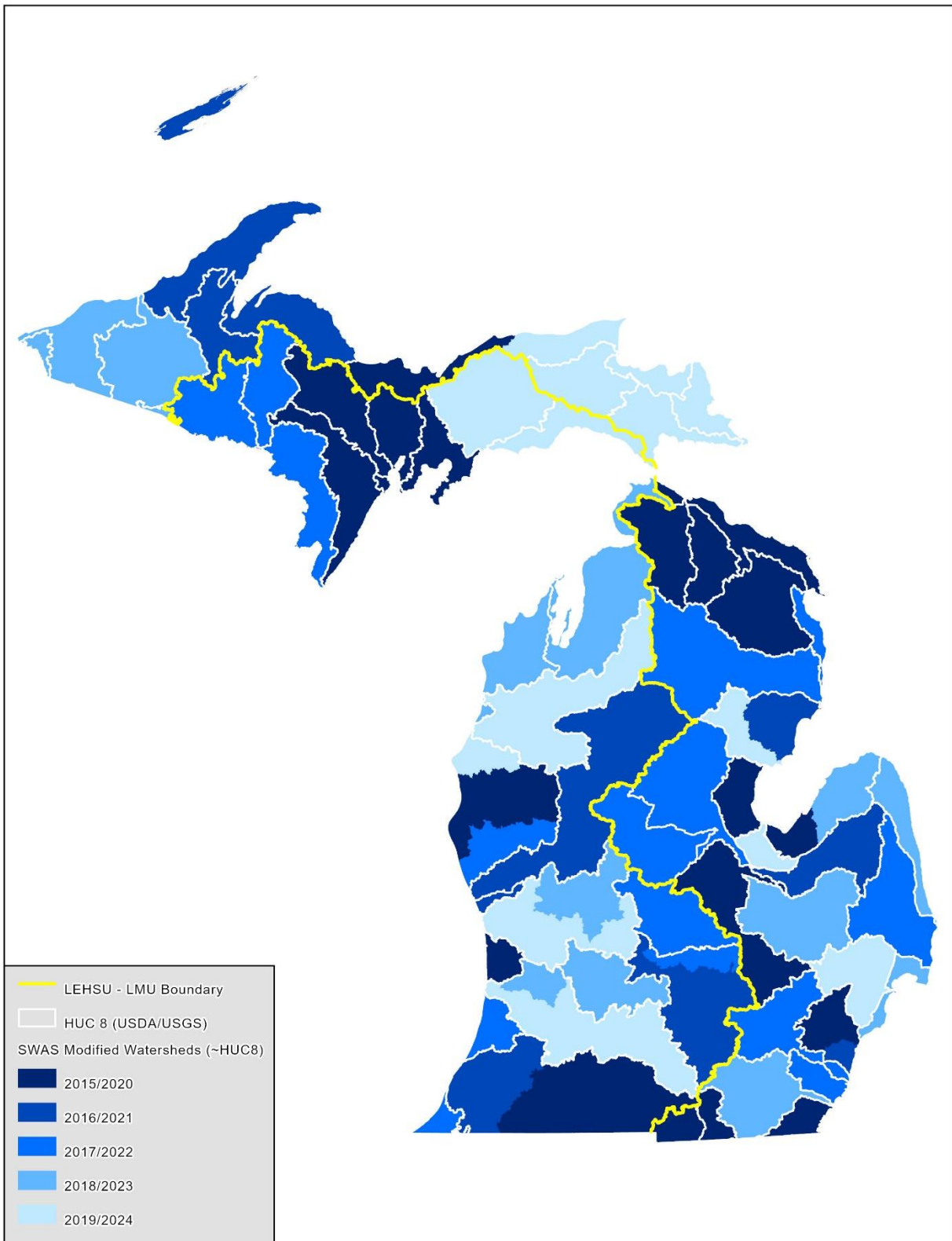


Figure 2.1. Five-Year Rotating Watershed Cycle.

CHAPTER 3 ASSESSMENT METHODOLOGY

3.1 Introduction

Michigan's assessment methodology describes the data and information used to determine designated use support, explains how these data and information are used to determine designated use support for surface waters of the state, and describes how surface water resources are reported using 5 categories (fully supporting, partially supporting, not supporting, insufficient information, or not assessed, described in more detail in Section 3.11). Ultimately, this methodology describes the process used to develop several of the appendices and summary tables included in this IR to satisfy the requirements of Sections 305(b) and 303(d) of the federal CWA.



The internal coordination and review process used to generate Sections 305(b) and 303(d) lists is carried out by a team of EGLE technical staff and managers with considerable knowledge of local watershed conditions/issues and expertise in aquatic biology, limnology, ecology, environmental engineering, chemistry, microbiology, and mammalian/aquatic toxicology.

3.2 Data and Information Used to Determine Designated Use Support

EGLE considers readily available, adequately georeferenced, and quality checked data and information collected and submitted by EGLE, its grantees and contractors, other agencies, and the public (including volunteer monitoring groups). Sources of data and information, in part, include:

- EGLE's water quality monitoring program that includes 8 interrelated elements: fish contaminants, water chemistry, sediment chemistry, biological integrity and physical habitat, wildlife contaminants, bathing beach monitoring, inland lakes monitoring, and stream flow (see Chapter 2).

As part of EGLE's water quality monitoring program, sites for biological integrity and water chemistry monitoring are selected using both targeted and probabilistic study designs. The probabilistic monitoring approach is used to address statewide and regional questions about water quality. Targeted monitoring is used to fulfill specific monitoring requests, assess known or potential problem areas or areas where more information is needed, achieve assessment coverage of a watershed, and provide information to support and evaluate the effectiveness of EGLE water protection programs (e.g., National Pollutant Discharge Elimination System (NPDES), Nonpoint Source (NPS), and Site Remediation). All site-specific data are considered to determine designated use support. Generally, the other types of monitoring are conducted using targeted study designs.

- Michigan's 2018 IR (EGLE, 2019a), which serves as a baseline for the 2020 IR and is modified using new data and information.
- Fish Consumption Advisories established by the Michigan Department of Health and Human Services (MDHHS).
- Dilution calculations, trend analyses, or predictive models for determining the physical, chemical, or biological integrity of surface water bodies.
- Reports of fish kills and chemical spills.
- Surface water quality monitoring data submitted by the general public or outside agencies. This information was solicited by EGLE in a notice on the EGLE Web-based Calendar in the following publications: May 10, 17, 24, 31, June 7, 14, and 21, 2019. Information was also solicited directly from an EGLE list-serve specific to Integrated Reporting and TMDLs which has a membership including various governmental (local to federal) agencies, State of Michigan agencies, tribal contacts, Michigan colleges and universities, watershed organizations, private consulting firms, and general citizens via e-mail on May 13, 2019. Data received from outside sources, and if and how they were used are summarized in Section 9.2.
- Public Water Supply taste and odor complaints as well as surface water, drinking water, and source water quality assessments conducted under Section 1453 of the federal Safe Drinking Water Act, enacted by Public Law 93-523, December 16, 1974, as amended, through August 6, 1996, being Title 42 of the United States Code (U.S.C.), Section 300j-13.
- Remedial investigation/feasibility studies to support Records of Decision under the Comprehensive Environmental Response, Compensation, and Liability Act, 1980 PL 96-510 or Part 201 of the NREPA.

To ensure adequate time for proper data analysis, EGLE applies a cutoff date for newly collected data considered for the IR (i.e., data that were not used for development of the 2018 IR). For the 2020 IR, unless otherwise noted below or in the methodology under each use, EGLE considered all new readily available and quality-checked water quality data and information collected by EGLE and its grantees/contractors within the 2-year period immediately following the cutoff date considered for the 2018 IR. In other words, data collected during the period from January 1, 2017, to December 31, 2018, were considered for the 2020 IR. Data collected prior to January 1, 2017, that were unable to be used for the 2018 IR or that were helpful to understand conditions over a longer period of time given limited datasets were considered for the 2020 IR using the current assessment methodology.

A 7-year span of available data were used with Water Chemistry Monitoring Program (WCMP) data to capture multiple sampling events and provide better supporting information on conditions over time. WCMP data collected through 2017 were used for this IR. WCMP data collected in 2018 were not quality-checked in sufficient time to be broadly used for this IR. However, data collected in 2018 and after the December 31, 2018, cutoff date are occasionally considered for inclusion in the 2020 IR on a case-by-case basis as determined appropriate by EGLE.

TMDL documents completed and approved by the USEPA through 2019 were used to prepare this IR. Water quality data collected since January 1, 2017, and submitted to EGLE by June 21, 2019, by other parties (e.g., in response to the data solicitation described above, from the Michigan Clean Water Corps volunteer monitoring database, etc.) were evaluated according to this assessment methodology and potentially used to help prepare the 2020 IR.

The quality assurance/quality control requirements for water, sediment, and fish tissue chemistry and biological data collected by EGLE are described in EGLE's Quality Management Plan (MDEQ, 2005). To ensure acceptable data quality, EGLE also requires all grantees or vendors receiving state or federal money for the purpose of conducting water quality monitoring to prepare and follow Quality Assurance Project Plans prior to sample collection (MDEQ, 2007). Other data, such as data submitted by outside agencies or the public, must satisfy EGLE's quality assurance/quality control requirements to be used to make designated use support determinations of supporting or not supporting, to change the designated use support, or to reassign water bodies to different categories. Data that do not fully satisfy EGLE's quality assurance/quality control requirements or data that are collected and analyzed using techniques that are less rigorous than techniques used by EGLE to make designated use support determinations may be used to list a water body for further evaluation (i.e., as insufficient information).

Each dataset for a water body is evaluated to determine if the data are representative of existing conditions and of adequate quality to make designated use support decisions. Data may not be representative of existing conditions if land use, point sources, or hydrologic conditions were substantially changed since the point of last data collection. Data may not be of adequate quality if field or laboratory methods changed to address quality concerns subsequent to data collection. In addition, the quantity of data; duration, frequency, magnitude, and timing of WQS exceedances; analytical method sensitivity; and contextual information (e.g., naturally occurring, weather, and flow conditions, etc.) are considered to ensure the data are representative of critical conditions. Target sample sizes may be given in this assessment methodology to determine designated use support; however, these sample sizes are not applied as absolute rules.

Generally, data that are collected to determine compliance with permitted activities, such as NPDES discharge data, are not used to determine designated use support; however, ambient data that are collected for this purpose will be considered. Similarly, although some foams associated with surface waters have been shown to contain PFOS, it is the associated water quality and fish tissue concentration data related to PFOS that will continue to be used for assessment and impairment listings. The presence of foam, absent additional data does not supply the information needed to adequately assess use attainment.

Water body, assessment, or data types not specifically discussed in this assessment methodology (including uncommon data or unusual circumstances) are considered on a case-by-case basis and are evaluated consistent with WQS.

3.3 Determination of Designated Use Support

At a minimum, all surface waters of the state are designated and protected for all of the following designated uses: agriculture, navigation, industrial water supply, warmwater fishery, other indigenous aquatic life and wildlife, partial body contact recreation, and fish consumption (R 323.1100[1][a]-[g] of the Part 4 rules). In addition, all surface waters of the state are designated and protected for total body contact recreation from May 1 to October 1 (R 323.1100[2]). Specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fisheries (R 323.1100[4]-[7]). Several specific segments or areas of inland waters, Great Lakes, Great Lakes bays, and connecting channels are designated and protected as public water supply sources (R 323.1100[8]). The Part 4 Rules form the basis for this assessment methodology.

Most designated uses have one or more types of assessment that may be used to determine support. For example, to determine support for the other indigenous aquatic life or wildlife designated use, biological or physical/chemical assessment (e.g., rapid bioassessment of the macroinvertebrate community or chemical analysis of water samples) may be used. The assessment types include biological, habitat, physical/chemical, toxicological, pathogen indicators, other public health indicators, and other aquatic life indicators (default types from the USEPA ATAINS). In addition, a variety of parameters may be considered for the same assessment type. For example, physical/chemical assessments to determine fish consumption designated use support may include analysis of mercury or PCB concentrations in the water column.

Michigan uses the principle of independent applicability when making most support determinations for each designated use for each water body. If data for more than one parameter with clear assessment thresholds (e.g., numeric criteria or water quality values) are available that are used to determine support for the same designated use, then each data type is evaluated independently to determine support for the designated use. If any one type of data indicates the designated use is not supported, then generally, the water body is listed as not supporting that designated use. In some instances, data require reevaluation to resolve discrepancies. When making assessment decisions based on narrative criteria without clear indicator thresholds or in situations using less standardized data sets a 'weight-of-evidence approach' is used to provide a context that evaluation of multiple data types brings. If no data are available for any assessment methods, then a water body is considered not assessed.

A single parameter may be used to make support determinations for more than one designated use. For example, appropriate data for a water body may reveal that water column mercury concentrations exceed the wildlife value and human noncancer value (HNV) (nondrinking water) (R 323.1057); therefore, both the other indigenous aquatic life and wildlife, and fish consumption designated uses are not supported. The inclusion of a parameter under a specific designated use in this assessment methodology does not preclude the use of that parameter to make support determinations for a different designated use.

Though infrequent, when best professional judgment (BPJ) is used to make a designated use support determination, justification is documented in the designated use comment field in the ATAINS record.

Water bodies listed as having insufficient information will generally be revisited in the correct basin year as resources allow (Figure 2.1).

3.4 Designated Uses: Agriculture, Navigation, and Industrial Water Supply

3.4.1 Assessment Type: No Specific Indicator or Assessment Method

EGLE does not conduct specific assessments to evaluate support of the agriculture, navigation, and industrial water supply designated uses. These uses are assumed to be supported unless there is site-specific information indicating otherwise. In a scenario where site-specific information is used, the information is evaluated on a case-by-case basis using BPJ.

3.5 Designated Use: Warmwater Fishery and Coldwater Fishery

All surface waters of the state are designated and protected for warmwater fishery. In addition, specific rivers and inland lakes as well as all Great Lakes and specific Great Lakes connecting waters are designated and protected for coldwater fishery per R 323.1100(4)-(7).

3.5.1 Assessment Type: Physical/Chemical

For the following parameters the ideal dataset for river/stream assessments will come from continuous data collection or similar frequent collection over a target time frame. Collecting data of a sufficient frequency over an appropriate duration is important to fully investigate fluctuations in parameter quality over time and during critical periods in flowing waters (e.g., predawn and midday dissolved oxygen monitoring to investigate diurnal swings). Inland lake data are important to collect during critical periods, particularly during stratified summer conditions as oxythermal habitat has the potential to be most limiting during those periods.

3.5.1.1 Dissolved Oxygen Concentration

River/Stream: Support determinations using dissolved oxygen data in Great Lakes, connecting waters and inland streams will typically be based on continuous data collected over a time period (e.g., two weeks) that is representative of conditions and captures environmental variability. Limited individual grab samples (e.g., 1 or 2 collected during other monitoring efforts) may generally be used only to assess a site as “insufficient information,” thereby recognizing the need for more specific and detailed monitoring to make a use support determination. Data should be collected with properly maintained equipment following the manufacturer’s guidelines. Current quality assurance/quality control procedures should be followed. Consideration of environmental conditions (e.g., weather, sample collection time of day, etc.) is especially important when making designated use determinations using dissolved oxygen concentrations. In general, a decision of “not supporting” for dissolved oxygen will be based on a 10 percent exceedance threshold following USEPA guidance (USEPA, 2002). If more than 10 percent of representative measurements (with continuous monitoring being the preferred method) exceed the criteria set forth in R 323.1064, the site is listed as “not supporting.” In addition to the guidelines outlined above (e.g., continuous monitoring preferred over a 2-week period), BPJ remains a factor in any case of support determinations using ambient dissolved oxygen for the warmwater and coldwater fishery designated uses. It is conceivable, although likely infrequent, that in using BPJ, a water body may be assessed with a less rigorous set of data (e.g., than the preferred continuous monitoring over a 2-week period), based on other environmental data concerns and/or multiple grab samples, showing degradation of water quality, collected over consecutive years or particularly egregious exceedance of WQS indicating obviously degraded conditions.

Inland Lake: Support determinations using dissolved oxygen data in inland lakes will typically be based, at a minimum, on dissolved oxygen profile data collected at the lake’s deepest point during summer stratification periods (ideally mid-July through August, taking into account annual weather pattern variability) from at least 2 of the most recent 5 years. Profile data collected during unstratified conditions is also helpful in comparing conditions to the applicable WQS. For coldwater lakes, as defined in R 323.1100(4) and (6), comparisons of available data will be made to R 323.1065(1)(a)-(d), to determine which subpart WQS is applicable based on historic knowledge of the lake’s most unaltered condition. Historic data, if available, will be helpful in determining the coldwater lake’s stratification category as described in R 323.1065(1)(a)-(d), which in turn defines the WQS goals. The four types of coldwater inland lakes are summarized as follows:

- 323.1065(1)(a): stratified coldwater lake with D.O. concentrations less than 7 mg/L in the upper half of the hypolimnion
- 323.1065(1)(b): stratified coldwater lake with D.O. concentrations greater than 7 mg/L in the upper half of the hypolimnion
- 323.1065(1)(c): stratified coldwater lake with D.O. concentrations greater than 7 mg/L throughout the hypolimnion
- 323.1065(1)(d): unstratified coldwater lake

Data not in keeping with the WQS defined in R 323.1065 (1)(a)-(d), as relevant, will typically result in a “not supporting” listing.

3.5.1.2 Temperature

Support determinations using temperature data will typically be based on continuous data collected over a time period (e.g., 2 weeks) that is representative of conditions and captures environmental variability. Limited individual grab samples (e.g., 1 or 2 collected during other monitoring efforts) may generally be used only to assess a site as “insufficient information,” thereby recognizing the need for more specific and detailed monitoring to make a use support determination. Data should be collected with properly maintained equipment using manufacturer’s guidelines. Current quality assurance/quality control procedures should be followed. Consideration of environmental conditions (e.g., weather, sample collection time of day) is especially important when making designated use determinations using temperature. In general, a decision of “not supporting” for temperature will be based on a 10 percent exceedance threshold following USEPA guidance (USEPA, 2002). If more than 10 percent of representative measurements (with continuous monitoring being the preferred method) exceed the criteria set forth in R 323.1069, R 323.1070, R 323.1072, R 323.1073, or R 323.1075, depending on water body type, the site is listed as “not supporting.” In addition to the guidelines outlined above (e.g., continuous monitoring preferred over a 2-week period), BPJ remains a factor in any case of support determinations using ambient temperature for the warmwater and coldwater fishery designated uses. During periods of extreme ambient air temperatures, it is assumed that stream temperatures will also rise. In some cases, this alone may cause temperatures to exceed criteria. BPJ to list a water body will be used in these situations. Likewise, it is conceivable, although likely infrequent, that in using BPJ, a water body may be assessed with a less rigorous set of data (e.g., than the preferred continuous monitoring over a 2-week period), based on other environmental data concerns and/or multiple grab samples, showing degradation of water quality, collected over consecutive years or particularly egregious exceedance of WQS indicating obviously degraded conditions.

3.5.1.3 Ammonia (un-ionized) Concentration

Support determinations of chronic conditions using un-ionized ammonia data will typically be based on grab sample data collected over a time period (e.g., 1 week) that is representative of conditions and captures environmental variability. Limited individual grab samples (e.g., 1 or 2 collected during other monitoring efforts) may generally be used only to assess a site as “insufficient information,” thereby recognizing the need for more specific and detailed monitoring to make a use support determination. Consideration of other relevant parameters (e.g., temperature, pH, total ammonia) is especially important when calculating un-ionized ammonia concentration to make designated use determinations. In general, a decision of “not supporting” for un-ionized ammonia will be based on more than 1 exceedance of the monthly average (chronic) WQS per R 323.1057 over the period of review (typically 2 years, see 3.2) following USEPA guidance (USEPA, 1999).

Support determinations of daily maximum (acute) conditions using un-ionized ammonia data will be based on following USEPA guidance; when comparing ambient water column data to Aquatic Maximum Values, more than 1 exceedance of the acute un-ionized ammonia WQS over the period of review will typically result in assessing the site as not supporting (USEPA, 1999).

In addition to the guidelines outlined above, BPJ remains a factor in any case of support determinations using un-ionized ammonia for the warmwater and coldwater fishery designated uses. It is conceivable, although likely infrequent, that in using BPJ, a water body may be assessed with a less rigorous set of data (e.g., than the preferred continuous monitoring over a 2-week period), based on other environmental data concerns and/or multiple grab samples,

showing degradation of water quality, collected over consecutive years or particularly egregious exceedance of WQS indicating obviously degraded conditions.

3.5.1.4 pH

Support determinations using pH data will typically be based on continuous data collected over a time period (e.g., 2 weeks) that is representative of conditions and captures environmental variability. Limited individual grab samples (e.g., 1 or 2 collected during other monitoring efforts) may generally be used only to assess a site as “insufficient information,” thereby recognizing the need for more specific and detailed monitoring to make a use support determination. Data should be collected with properly maintained equipment using the manufacturer’s guidelines. Current quality assurance/quality control procedures should be followed. Consideration of environmental conditions (e.g., weather, sample collection time of day) is especially important when making designated use determinations using pH. In general, a decision of “not supporting” for pH will be based on a 10 percent exceedance threshold following USEPA guidance (USEPA, 2002). If more than 10 percent of representative samples (with continuous monitoring being the preferred method) exceed the criteria set forth in R 323.1053, the site is listed as “not supporting.” In addition to the guidelines outlined above (e.g., continuous monitoring preferred over a 2-week period), BPJ remains a factor in any case of support determinations using pH for the warmwater and coldwater fishery designated uses. It is conceivable, although likely infrequent that in using BPJ, a water body may be listed with a less rigorous set of data (e.g., the preferred continuous monitoring over a 2-week period), based on other environmental data concerns and/or multiple grab samples, showing degradation of water quality, collected over consecutive years or particularly egregious exceedance of WQS indicating obviously degraded conditions.

3.5.1.5 Water Column Toxic Substance Concentrations

To determine warmwater and coldwater fishery designated use support using toxic substances that are non-Bioaccumulative Chemicals of Concern (BCC), ambient water column chemical concentrations are compared to Aquatic Maximum Values and Final Chronic Values per R 323.1057 using Figure 3.1a and following the process described in 3.6.1.1.

3.5.2 Assessment Type: Biological

3.5.2.1 Fish Community

In addition to chemical and physical assessment types, Michigan uses rapid bioassessment of fish communities in wadeable streams and rivers (generally Procedure 51 [P51] [MDEQ, 1990]) to determine support for the warmwater fishery and coldwater fishery designated uses. Fish community biosurvey sites are generally selected using targeted study designs.

Rivers and streams with no site-specific fish community biosurvey results are considered not assessed unless other data are available to assess this use as described elsewhere in this Section (3.5).

Using P51, warmwater fish communities are scored with metrics that rate water bodies from excellent (+5 to +10) to poor (-10 to -5). Fish ratings from -4 to +4 are considered acceptable (Creal et al., 1996). Water bodies with warmwater fish communities rating acceptable or excellent using P51 are determined to support the warmwater fishery designated use. Fish communities collected from designated coldwater streams using P51 are determined to support the coldwater fishery designated use if the relative abundance of salmonids is equal to or greater than 1%. One bioassessment result is generally considered sufficient to make this determination.

Using P51, a determination of not supporting or, infrequently, insufficient information is made for water bodies that have metrics that rate the warmwater fish community poor, have coldwater fish communities with salmonid relative abundance of less than 1%, if fewer than 50 fish are collected, or if the relative abundance of fish with anomalies exceeds 2% (applies to both warmwater and coldwater fisheries). Generally, targeted biosurvey results should have sufficient supporting information available to determine survey representativeness and to list the water body as not supporting using one survey result. However, instances where other supporting information raise concerns over data quality and representativeness (e.g., a poor fish community result during high-water conditions or when equipment function was in question) may require the collection of additional information to determine data representativeness. In this case, a determination of insufficient information is made.

For fish communities that rate poor, current and past weather conditions, assessments of biological communities in adjacent stream or river segments, historic data, and the source and frequency of pollutant exposure are considered to determine if conditions are ongoing or temporary. If conditions are determined to be temporary, a water body may be listed as having insufficient information. For example, a water body with a temporarily poor biological community due to a short-term chemical spill may be listed as having insufficient information if remediation occurred and the community is expected to recover.

Fish community data for streams, rivers, and lakes collected using methods other than P51 are evaluated on a case-by-case basis. For example, fish community data collected as part of the MDNR Fisheries Division's Status and Trend monitoring can be evaluated based on community structure and compared to the definitions for coldwater and warmwater fishery use as stated in R 323.1043 and R 323.1044. Additional factors considered in determining support of the fishery designated uses are the presence of indicator species such as cisco in coldwater lakes or walleye in warmwater lakes at densities sufficient to indicate water body support of a healthy food web that could maintain taxa of such trophic levels. Similarly, the absence of indicator species where they historically existed, particularly in coldwater lakes (e.g., cisco), will be considered in combination with other information such as oxythermal profile data, to identify potential impairments to the fish community. Data on indicator species absence, while difficult to quantify with ultimate certainty, will be considered in a weight-of-evidence approach from a number of proven sources such as creel data, fish community sampling (netting, electrofishing, etc.), as well as potentially useful emerging tools (e.g., eDNA) as efficacy is demonstrated.

When evaluating this information, 2 biologists with fisheries experience independently assess fish community data relative to the definitions in the rules and their assessments are subsequently compared. Assessments with agreement (e.g., both biologists rating the data as 'fully supporting' the fishery designated use) are used to assess the appropriate assessment unit as such. Assessments with disagreement (e.g., one biologist rating the data as 'fully supporting' while the other rates it as 'not supporting') result in discussions of the data and agreement reached or a rating as 'insufficient information' to generate additional data collection to fully assess the assessment unit in question.

3.6 Designated Use: Other Indigenous Aquatic Life and Wildlife

3.6.1 Assessment Type: *Physical/Chemical*

3.6.1.1 Water Column Toxic Substance Concentrations

To determine other indigenous aquatic life and wildlife designated use support using toxic substances, ambient water column chemical concentrations are compared to Wildlife, Aquatic Maximum, and Final Chronic Values per R 323.1057 using Figures 3.1a and b, as described

below. Water chemistry monitoring sites are selected using both targeted and probabilistic study designs. All site-specific water column chemistry data that are determined to be representative of current conditions are used to determine other indigenous aquatic life and wildlife designated use support. Additionally, site-specific water column chemistry data for non-BCCs are also used to determine warmwater and coldwater fishery designated use support, as described in Section 3.5.1.5. and illustrated in Figure 3.1a, below.

A minimum of 4 data points in a year are generally used to assess toxic substances per USEPA guidance (USEPA, 2002). In rare instances, and particularly in the case of acute WQS, limited data (less than 4 data points) demonstrating exceedance of WQS may be used to assess a water body as not supporting; if so, the basis for these decisions will be reflected in ATTAINS. A 7-year window of the most recent quality assured data is used for WCMP information to capture 2 probabilistic monitoring events spaced 5 years apart.

Following USEPA guidance, when comparing ambient water column data to Final Chronic Values for non-BCCs, more than one exceedance of the WQS over the period of review (typically 7 years in Michigan's review process) will typically result in assessing the site as not supporting, as illustrated in Figures 3.1a and 3.1b (USEPA, 2002). Similarly, to be reflective of the need to protect aquatic life against acute impacts, when comparing ambient water column data to Aquatic Maximum Values for BCCs and non-BCCs, 1 or more exceedance of the WQS over the period of review will typically result in assessing the site as not supporting, as illustrated in Figures 3.1a and b. For BCCs, comparisons of ambient water column data to Wildlife Values (the most sensitive chronic value) will be made using geometric means of available data as illustrated in Figure 3.1b. Geometric mean is chosen to help interpret the data when Wildlife Values are most sensitive because these criteria are based on long-term exposure of wildlife to surface water for drinking and consuming fish tissue. This is an analogous approach to that used when assessing human health protection as recommended per USEPA guidance (USEPA, 2002).

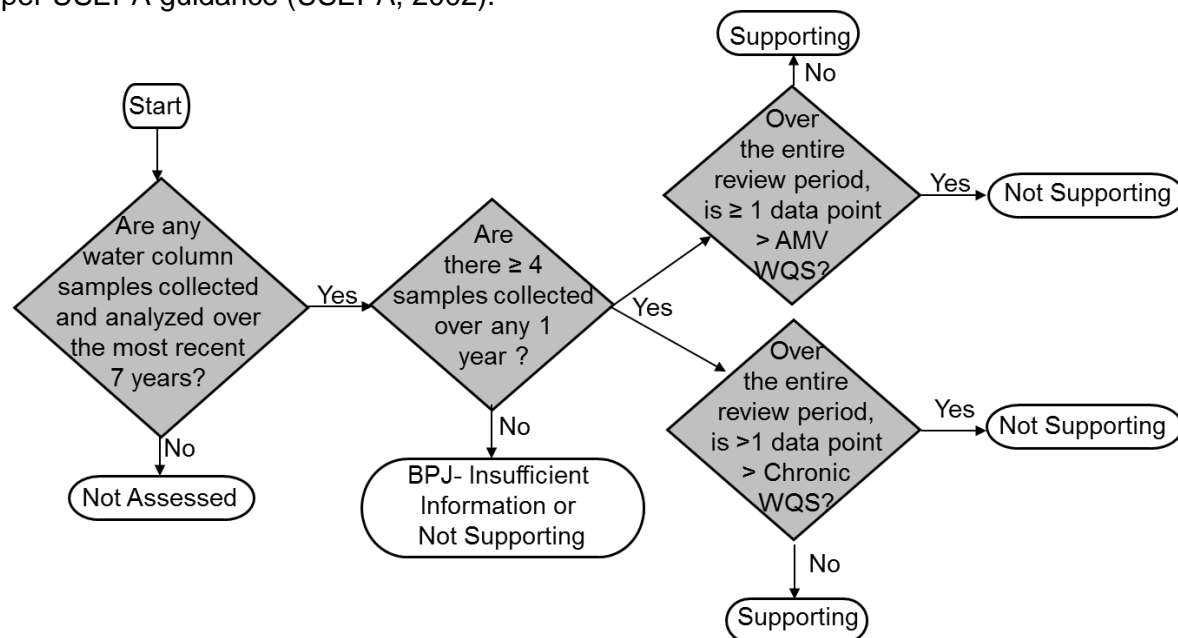


Figure 3.1a. Determination of other indigenous aquatic life and wildlife and warmwater/coldwater fishery designated uses support using water column toxic substance concentration for non-BCCs.

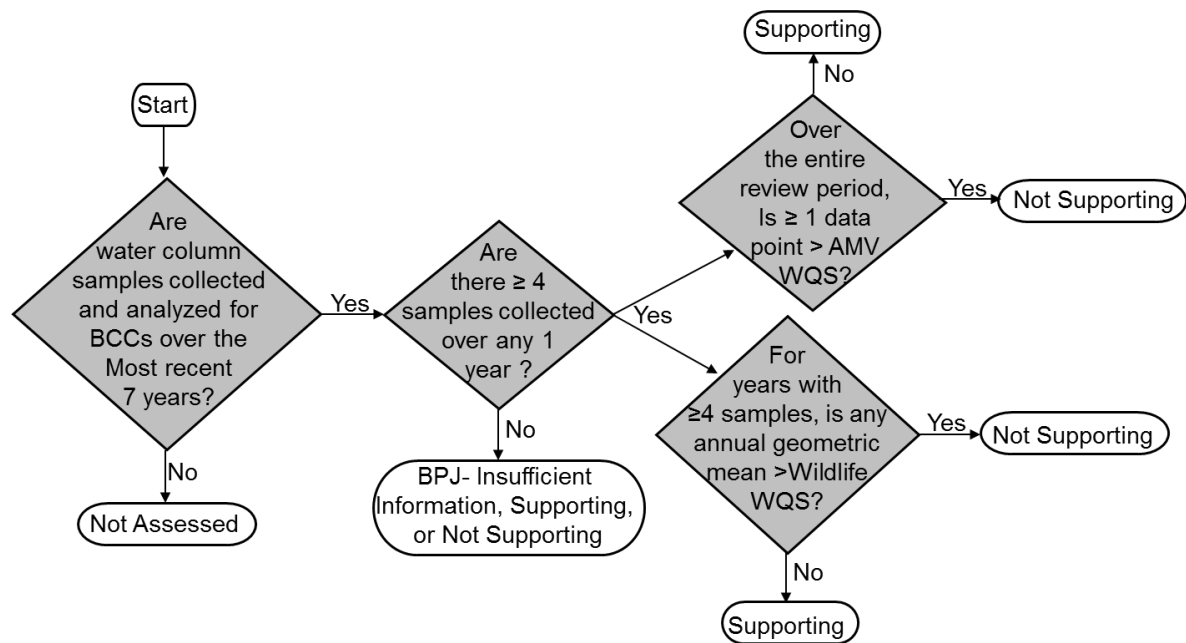


Figure 3.1b. Determination of other indigenous aquatic life and wildlife designated use support using water column toxic substance concentration for BCCs.

Site-Specific Aquatic Life Criteria may be developed following Rule 323.1057(2)(r)(ii). If Site-Specific Aquatic Life Criteria are developed, determination of designated use support status will be assessed following the processes in Figures 3.1a and b, as appropriate with water column data assessed against the corresponding Site-Specific Aquatic Life Criteria.

3.6.1.2 Water Column Nutrient Concentrations

For all waters, ambient water column nutrient concentrations are used in conjunction with biological indicators to determine support of the other indigenous aquatic life and wildlife designated use in all surface waters per R 323.1060 using BPJ to interpret conditions related to this narrative standard. Samples collected during July through September, when the impacts due to nutrient expression are most likely to occur, are particularly important for making designated use support determinations.

Nutrient concerns may generate the need to conduct additional studies on possible ecological effects, including indirect effects to dissolved oxygen concentrations that may impact the fish community. If so, the results of those studies may be used to assess the warmwater and coldwater fishery designated uses following Section 3.5.1.1 thereby linking nutrient impacts to those uses as well depending on the monitoring outcome.

For inland lakes, various data are useful in a 'weight-of-evidence' approach to determine designated use support. Supporting information may include a combination of Carlson's trophic status index (TSI) and water chemistry results for various nutrients or cyanotoxins, as discussed below, as well as reports of nutrient expression/blooms, aerial imagery showing visible blooms and extent, aquatic nuisance control documentation, and aquatic macrophyte surveys (as described in Section 3.6.2.2).. All are potentially useful in demonstrating frequent impact to designated use support, although TSI and evidence of frequent, persistent blooms are most useful in demonstrating a nutrient-enriched system. Data within a 10-year time frame are most relevant to the assessment process. However, data older than 10-years may be useful support information coupled with more recent data.

Inland lakes classified as oligotrophic, mesotrophic, or eutrophic are generally determined to support the other indigenous aquatic life and wildlife designated use, unless other information exists regarding designated use impacts resulting from excess nutrients (e.g., persistent and significant algal blooms). Trophic classifications of lakes as hypereutrophic, or occasionally eutrophic, coupled with additional information discussed above are all potentially supportive lines of evidence for a designated use assessment. Inland lakes that are classified as hypereutrophic, but without additional supporting information regarding nutrient expression, are generally listed as insufficient information with the goal of conducting additional site-specific monitoring to confirm the trophic designation and provide additional supportive information.

Data considerations for inland lake designated use assessment include the following indicators, and those found in Section 3.6.2.2:

- *TSI calculation* – Trophic state determinations for inland lakes in Michigan have typically used data collected during comparable late summer time frames with consistent sample collection methods (e.g., primarily EGLE monitoring data, USGS Lake Water Quality Assessment data [Fuller and Taricska, 2012], or Cooperative Lake Monitoring Program volunteer data [<https://micorps.net/lake-monitoring/individual-lake-reports/>]).

Individual TSI values are calculated using summer data for each trophic state indicator: summer secchi depth (transparency), total phosphorus concentration (epilimnetic), and chlorophyll a concentration (photic zone) (Table 3.1).

An overall TSI is determined from the mean of the individual indicator TSI values to provide a way of reducing the effects of individual sampling and measurement errors, thus developing a more robust estimate of the index. Based on these index values the trophic status classification is determined as listed in Table 3.2 (Fuller and Taricska, 2012). Carlson's index may underestimate the trophic state of lakes dominated by macrophytes. Therefore, the relative abundance of submergent macrophytes, if available, is used to indicate more productive conditions than indicated by the TSI values. It is assumed that moderate and dense growths of macrophytes are indicative of mesotrophic and eutrophic conditions, respectively. Therefore, if Carlson's TSI indicate mesotrophic conditions, but dense macrophytes are present, the lakes will be classified eutrophic (MDEQ, 2013a).

Priority is given to monitoring events with all three parameters (secchi depth, total phosphorus concentration, chlorophyll-a concentration) collected during the summer in the deep point of the lake by a program with an existing quality assurance or work plan (typically, but not exclusively, state, federal, or university collections). However, data collected by other sources, with fewer parameters, or gathered using somewhat different methods may be useful in calculating TSI values for lakes where TSI information is lacking or to investigate support for additional lines of evidence.

For example, the use of data collected prior to 2013 during the USEPA-sponsored National Lakes Assessments, and by Michigan tribes, the National Park Service, and potentially other sources (e.g., volunteer monitoring, MDNR, Fisheries Division or through satellite imagery interpretation of secchi depths) is considered on a case-by-case basis.

The total phosphorus and chlorophyll-a samples collected during these efforts may deviate from the standard sampling methods used by EGLE at Michigan lakes to characterize TSI but remain useful for assessments. Similarly, data collected from shoreline areas may be useful in providing ancillary support for other available information.

- *Water chemistry results: nutrients and cyanotoxins* – In addition to visible signs of expression, associated water chemistry information may also be indicative of nutrient-enriched lakes and may be useful as a component of the assessment process. Total phosphorus less than 30 ug/L in the water column has been shown to generally not cause nuisance plant and algal conditions (Watson et al., 1992; Soranno et al., 2008; and Carvalho et al., 2013).

Although intense cyanobacteria blooms may not produce toxins, when concentrations of cyanotoxins are detected they are often tied to extensive visible cyanobacteria blooms and are an additional support for nuisance nutrient expression.

Table 3.1. Carlson's TSI Equations.	
$TSI_{SD} = 60 - 14.40 \ln SD$	SD = Secchi depth transparency (m)
$TSI_{TP} = 4.15 + 14.42 \ln TP$	TP = total phosphorus concentration (ug/l)
$TSI_{CHL} = 30.6 + 9.81 \ln CHL$	CHL = chlorophyll a concentration (ug/l)

Table 3.2 Michigan Inland Lakes Trophic Status Classification Criteria.				
Trophic State	Carlson's TSI	TP (ug/l)	SD (m)	CHL (ug/l)
Oligotrophic	<38	<10	>4.6	<2.2
Mesotrophic	38-48	10-20	2.3-4.6	2.2-6
Eutrophic	49-61	21-50	0.9-2.2	6.1-22
Hypereutrophic	>61	>50	<0.9	>22

3.6.1.3 Ammonia (un-ionized) Concentration

Support determinations of chronic and acute conditions using un-ionized ammonia data to assess the other indigenous aquatic life and wildlife designated use follow the processes found in Section 3.5.1.3.

3.6.1.4 pH

Support determinations using pH data to assess the other indigenous aquatic life and wildlife designated use will follow the process found in Section 3.5.1.4.

3.6.1.5 Physical Characteristics

R 323.1050 addresses the following physical characteristics of a water body: turbidity, color, oil films, floating solids, foams, settleable solids, suspended solids, and deposits. Michigan does not have specific assessment methods or numeric standards for these physical characteristics; therefore, BPJ (including visual observation) in conjunction with other assessment types (e.g., biological) is used to determine the other indigenous aquatic life and wildlife designated use support based on this narrative standard.

3.6.2 Assessment Type: Biological

3.6.2.1 Macroinvertebrate Community

In addition to chemical and physical assessment types, Michigan uses rapid bioassessment of macroinvertebrate communities in wadeable streams and rivers (generally P51; MDEQ, 1990) to determine support for the other indigenous aquatic life and wildlife designated use. Using P51, macroinvertebrate communities are scored with metrics that rate water bodies from excellent (+5 to +9) to poor (-5 to -9). Macroinvertebrate ratings from -4 to +4 are considered acceptable (Creal et al., 1996). Biosurvey sites are selected using both targeted and

probabilistic study designs. All biosurvey data are considered to determine other indigenous aquatic life and wildlife designated use support.

Rivers and streams with no site-specific macroinvertebrate community biosurvey results are considered not assessed unless other data are available to assess the use as described elsewhere in this Section (3.6).

Water bodies with macroinvertebrate communities rating acceptable or excellent (i.e., total P51 macroinvertebrate community score -4 to +9) are determined to support the other indigenous aquatic life and wildlife designated use. One bioassessment result is generally considered sufficient to make this determination.

A determination of not supporting or, infrequently, insufficient information is made for water bodies with macroinvertebrate communities rated poor (total P51 macroinvertebrate community score -5 to -9). Generally, targeted biosurvey results should have sufficient supporting information available to determine survey representativeness and to list the water body as not supporting using one survey result. For biological communities that rate poor, current and past weather conditions, relevant available historic data, assessments of biological communities in adjacent stream or river segments, and the source and frequency of pollutant exposure are considered to determine if conditions are ongoing or temporary. In all cases, ATTAINS reflects the information used to support the assessment decisions.

Macroinvertebrate data for wadeable streams and rivers collected using methods other than P51 are evaluated on a case-by-case basis. Similarly, biological integrity data regarding water bodies where P51 is not appropriate (e.g., wetlands, lakes, ephemeral streams, etc.) will be evaluated on a case-by-case basis using BPJ to assess community characteristics like taxa balance, diversity, and other indicators of system health and function.

Nonwadeable rivers are assessed using Michigan's Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers (MDEQ, 2013b). Using this nonwadeable procedure, macroinvertebrate communities are scored with metrics that rate water bodies from excellent to poor. Macroinvertebrate ratings from 76-100 are considered excellent, 50-75 good, 25-49 fair, and 0-24 are considered poor.

Nonwadeable rivers with macroinvertebrate communities rating excellent, acceptable, or fair (i.e., total macroinvertebrate community score ≥ 25) are determined to support the other indigenous aquatic life and wildlife designated use. One bioassessment result is generally considered sufficient to make this determination.

Similar to determinations made for wadeable streams and rivers, a determination of not supporting or insufficient information is made for nonwadeable rivers with macroinvertebrate communities rated poor (total macroinvertebrate community score 0-24) depending on the quality and amount of supporting contextual information available.

3.6.2.2 Bacteria, Algae, Macrophytes, and Fungi

Site-specific visual observations of bacteria, algae, macrophytes, and fungi may be used to make a support determination for the other indigenous aquatic life and wildlife designated use. In addition, water column nutrient concentrations may also be used to support this determination (see Section 3.6.1.2).

A determination of not supporting will be made if excessive/nuisance growths of algae (particularly, *Cladophora*, *Rhizoclonium*, and cyanobacteria) or aquatic macrophytes are present. Although the determination of excessive, nuisance conditions is generally made using

BPJ in accordance with narrative WQS, P51 offers the following guidance to make these determinations for streams:

- *Cladophora* and/or *Rhizoclonium* greater than 10-inches long covering greater than 25% of a riffle.
- Rooted macrophytes present at densities that impair the designated uses of the water body.
- Presence of bacterial slimes.

For inland lakes and impoundments, chlorophyll *a* (used as a surrogate for algal biomass) is a component of the TSI calculation and is used quantitatively to determine the trophic state (see Section 3.6.1.2). Additionally, the following data are considered for inland lake designated use assessment in combination with indicators in 3.6.1.2:

- *Bloom reports/complaints* – These should be documented through existing EGLE avenues of either the Environmental Assistance Center, Pollution Emergency Alerting System, or the AlgaeBloom@michigan.gov email. Ideally, reports are most useful if they include photos with descriptions of the extent and duration the bloom has been visible. Repeated annual or intra-annual complaints or documentation of blooms provide useful information on frequent blooms over time (e.g., more than one bloom report in the past 5 years), and the persistence of those blooms when they occur (e.g., more than one bloom report in a season, separated by at least one week).
- *Aerial Imagery* – Visible indication of any bloom (green or blue-green) extent from high-resolution satellite imagery, typically available through online applications, may be useful in corroborating whether blooms have occurred historically. The specific time frame of the images used should be available for perspective when relating to other available information. Other, more frequently obtained images, such as those used in various forecasting efforts by NOAA, are useful in their ability to aid in the evaluation of both extent and duration of blooms.
- *Aquatic Nuisance Control Permits* – Information on target plants and the extent and frequency of treatment are useful information in identifying potentially persistent nutrient expression. For purposes of assessment, the extent of treatment beyond 30% of the littoral zone is considered moderately extensive and an indication of broad nutrient expression, particularly when those treatments occur over more than one year in the past five. Additionally, multiple treatments within a season are summarized by the ratio of total cumulative area treated over the season to the unique area treated within the lake; ratios equal or higher than 3 are considered to indicate persistence in nutrient availability and vegetation presence throughout the growing season.

The presence of an extensive nuisance control program on a lake that successfully alleviates nutrient expression through treatment may be a supportive line of evidence in an impairment determination; the masking of problems through herbicide application represents a short-term fix that does not address root causes that would otherwise be impacting the lake.

3.6.2.3 Sediment Toxicity

The results of sediment toxicity studies on freshwater invertebrates may be used in conjunction with supporting data from sediment chemistry analyses and/or additional site-specific information, to make support determinations for the other indigenous aquatic life and wildlife designated use. Sediment toxicity tests must be conducted following USEPA Methods 100.1 or 100.2, or a similar test, and must incorporate test acceptability requirements and other quality

control steps (USEPA, 2000). It is important from an assessment standpoint that the control-corrected sediment toxicity be further supported by additional information, which lends confidence to the results and reduces the potential of making a listing decision based on possible laboratory error during the testing process. As such, sediment analyses, in-situ biological assessments, or other information in support of toxicity analyses results are necessary to make a full assessment determination following the process in Figure 3.2.

The determination of spatial area represented by toxicity tests will rely on associated information regarding sediment deposit mapping and other site-specific information that supports the likely extent of impacted areas.

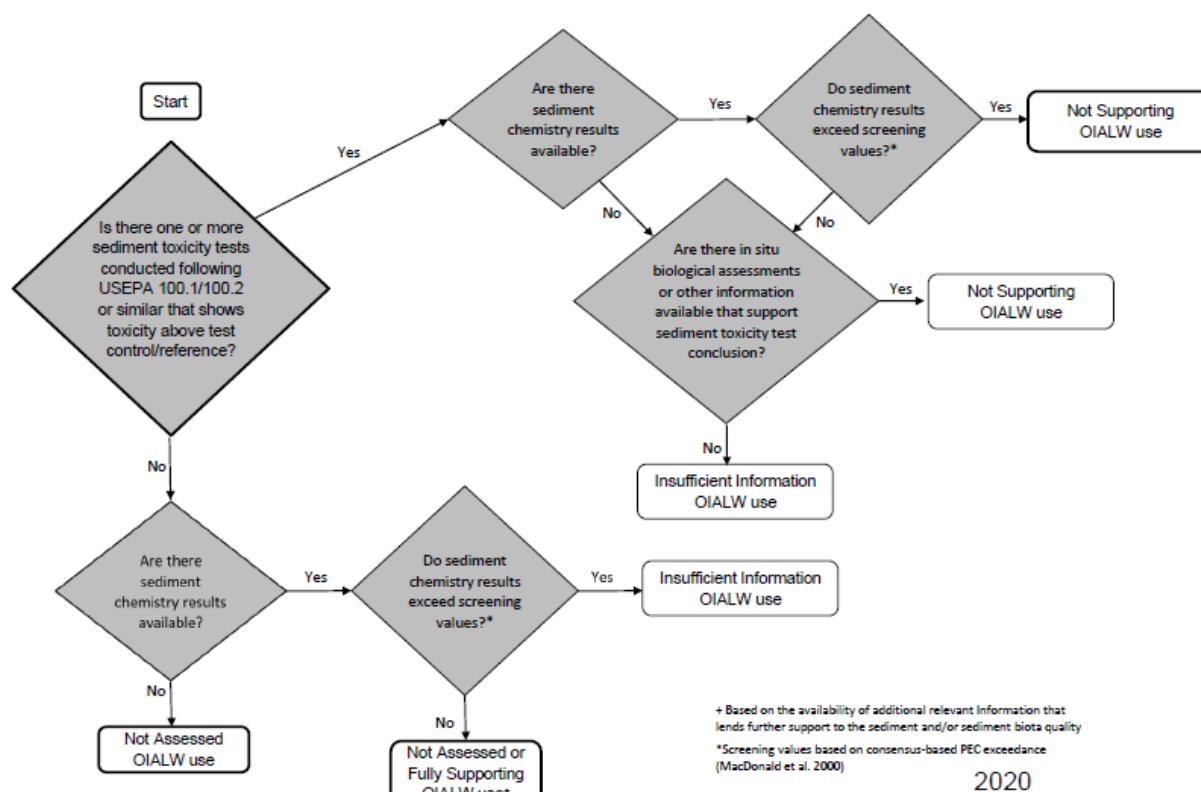


Figure 3.2. Determination of other indigenous aquatic life and wildlife designated use support using sediment toxicity.

3.7 Designated Use: Partial Body Contact Recreation and Total Body Contact Recreation

The partial body contact recreation designated use applies to all water bodies the entire year, while the total body contact recreation designated use applies to all water bodies during May 1 to October 31.

3.7.1 Assessment Type: Pathogen Indicators

3.7.1.1 *E. coli*

Michigan uses ambient *E. coli* concentration, and the presence of raw sewage discharges, to determine partial body contact and total body contact recreation designated use support using Rule 323.1062 and following Figures 3.3a and 3.3b, respectively. A minimum of 5 sampling events are needed to assess the partial and total body contact recreation designated uses using *E. coli* data. For the 30-day geometric mean total body contact WQS to be evaluated, the

sampling events must be “representatively spread over a 30-day period” (Rule 323.1062). A sampling event is defined by Rule 323.1062 as “three or more samples taken during the same sampling event at representative locations within a defined sampling area.” Available quality-checked riverine *E. coli* data, including those from the year immediately preceding the IR cycle, may be used in assessments (e.g. data from 2017 through 2019 may be used during the 2020 IR cycle). Larger datasets (e.g., weekly over the total body contact season or over multiple years) should be used to their fullest extent when available to assure that changing conditions during the year or over multiple years are adequately represented. For example, assessments of bathing beaches for which the most recent 2 years of data indicate a shift in status (fully supporting to not supporting or vice versa), were expanded to use an additional year of data to increase confidence in changing conditions. A 10 percent exceedance threshold is targeted for making designated use determinations following USEPA guidance (USEPA, 2002). However, discretion may be used when considering a single violation and the magnitude of the exceedance under certain circumstances using small datasets (USEPA, 2002).

The representativeness of *E. coli* data is critical in assessing use attainment. It is important that the *E. coli* data used be spaced over time to represent a range of conditions rather than be clustered around a single event (e.g., single rain event or a single dry weather event). It is acceptable to sample during a critical 30-day period that may be driving *E. coli* concentrations (e.g., summer low flow, wet weather conditions) as long as they are distributed representatively over that time frame. Data used for reassessing an assessment unit previously listed as not supporting should, at a minimum, capture conditions that were reflected in the data used to make the initial assessment. For example, if wet weather events were captured as part of an initial dataset used to list an assessment unit as not supporting, it would be inappropriate to use only dry weather data to assess for delisting purposes. Additionally, when using more extensive datasets, the breadth of the data used is contingent on confidence that it represents conditions and variability typical of the water body being assessed.

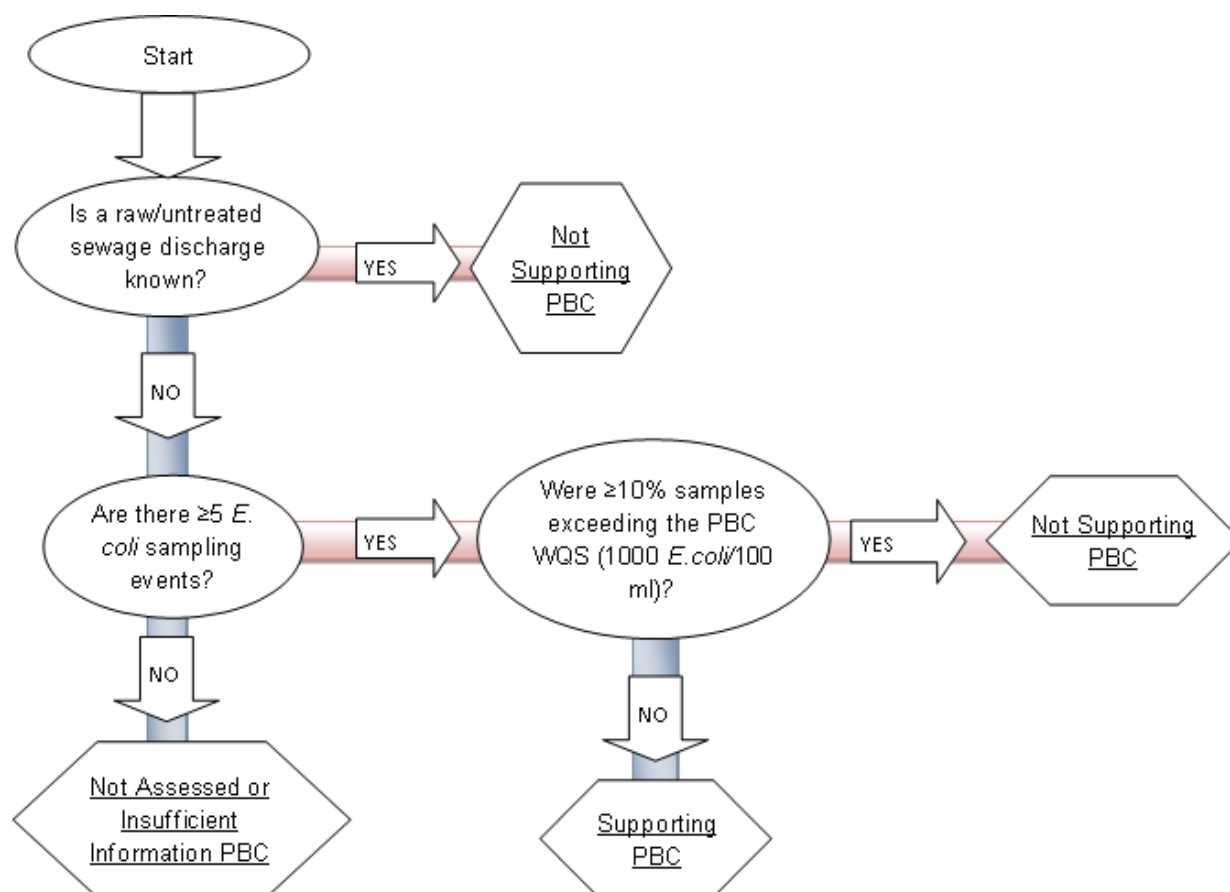


Figure 3.3a. Determination of partial body contact designated use support using ambient *E. coli* water column concentration. See Section 3.7.1.1 for additional details.

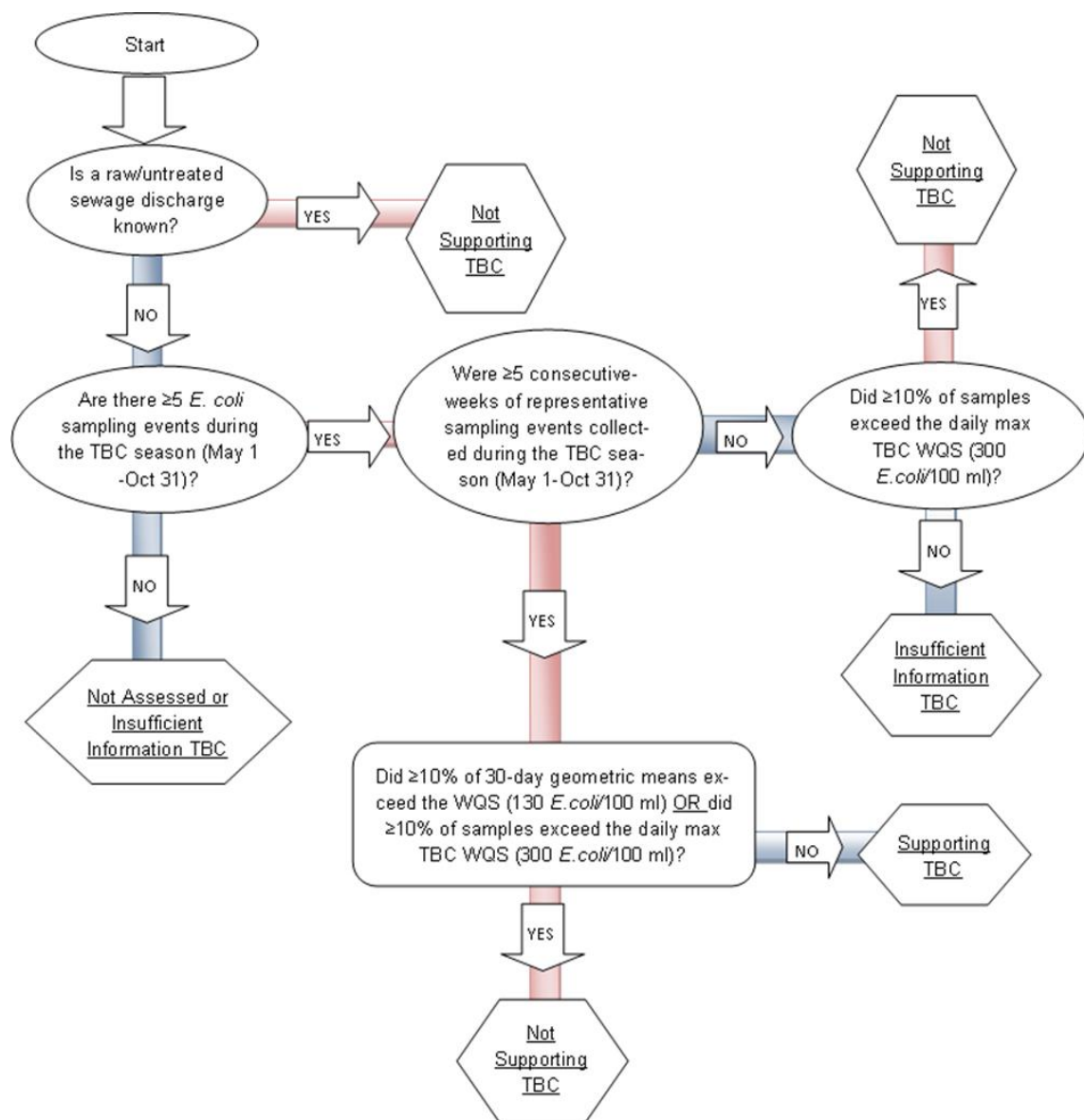


Figure 3.3b. Determination of total body contact designated use support using ambient *E. coli* water column concentration. See Section 3.7.1.1 for additional details.

3.7.2 Assessment Type: Physical/Chemical

3.7.2.1 pH

A determination of not supporting may be made in situations where the pH of surface water is such that direct human contact presents an opportunity for physical danger (e.g., contaminated groundwater venting from cement kiln dust disposal sites). Although infrequent, in such situations decision processes will be captured in relevant comment fields under affected Assessment Units within ATTAINS.

3.8 Designated Use: Fish Consumption

Michigan uses the concentration of BCCs (as listed in Table 5 of the Part 4 Rules) and other bioaccumulative substances (selenium and perfluorooctane sulfonate) in the water column, and fish consumption advisories issued by the MDHHS to determine fish consumption designated use support. A water body is considered to not support the fish consumption designated use if either the MDHHS has issued a site-specific fish consumption advisory for that water body or ambient water column concentrations exceed WQS, as described below.

3.8.1 Assessment Type: Physical/Chemical

3.8.1.1 Water Column and Fish Tissue Mercury Concentrations

A fish consumption designated use decision based on ambient water column mercury concentrations is made by comparing mercury concentrations in the water with the HNV (nondrinking water) WQS (1.8 nanograms per liter [ng/L]) following the flow chart in Figure 3.4. In keeping with the assessment process spelled out in Section 3.6.1.1, geometric mean is chosen to help interpret the data when comparing to HNV because these criteria are based on long-term exposure to surface water for consuming fish tissue.

Michigan's fish tissue mercury value development method is similar to the USEPA's development method for the national fish tissue criterion (USEPA, 2001). Michigan's fish tissue mercury value (0.35 milligrams per kilogram [mg/kg]) was derived using the same exposure scenario used to derive Michigan's HNV (nondrinking water) WQS of 1.8 ng/L. Michigan's fish tissue value for mercury is the concentration that is not expected to pose a health concern to people consuming 15 grams or less of fish per day. This fish tissue value of 0.35 mg/kg for mercury is used as the decision point for making nonattainment listing decisions using the previous two years of available tissue data, 2016-2017 for this 2020 IR. The 2 meal per month MDHHS advisory level based on mercury equates to tissue mercury concentrations in edible portions over a range (0.27-0.53 mg/kg wet weight), encompassing Michigan's fish tissue value for mercury (0.35 mg/kg wet weight).

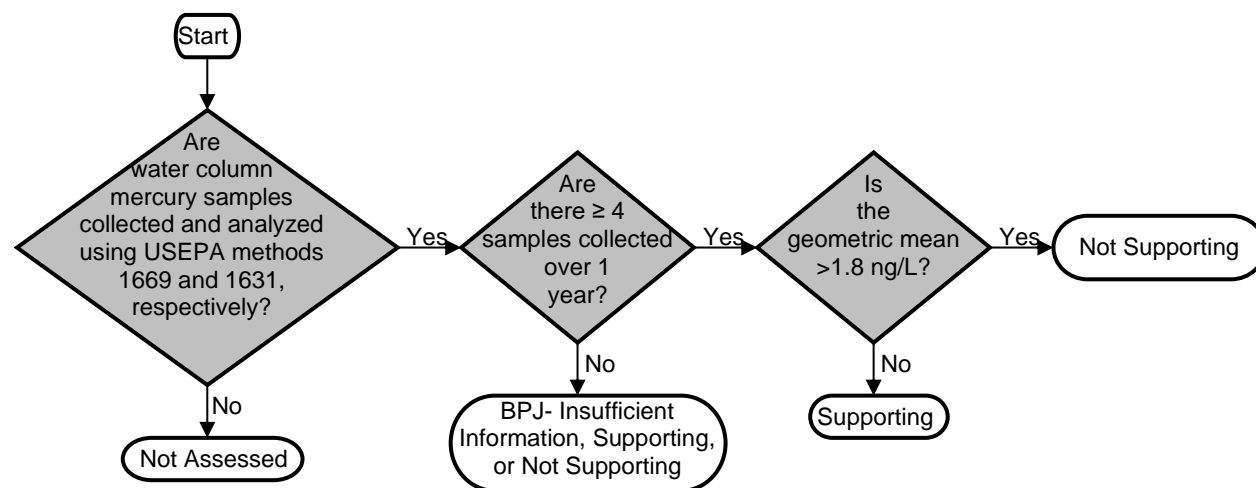


Figure 3.4a. Determination of fish consumption designated use support using water column mercury concentration.

3.8.1.2 Water Column PCB Concentration

To determine fish consumption designated use support for PCBs, the ambient water column PCB concentration is compared to the non-drinking water Human Cancer Value (HCV) (0.026 ng/L) (R 323.1057). PCB samples should be collected and analyzed according to protocols published by the USEPA (1997a and 1997b), with the exception that dissolved and particulate fractions are combined. For PCBs, a sample size of 1 is considered sufficient information to determine WQS nonattainment. This approach is justified by the existence of a large PCB dataset for the state as a whole, which shows virtually 100% exceedance of the HCV for total PCBs. If there are no appropriate PCB data, then a water body is considered not assessed. Water bodies with 1 or more ambient water column PCB sample results greater than the non-drinking water HCV are determined to not support the fish consumption designated use.

3.8.1.3 Water Column BCCs Concentration other than Mercury and PCBs

To determine fish consumption designated use support for BCCs other than mercury and PCBs in the water column, ambient water column chemical concentrations are compared to the HNV and HCV for nondrinking water per R 323.1057 using Figure 3.4b and following the process described in Section 3.6.1.1.

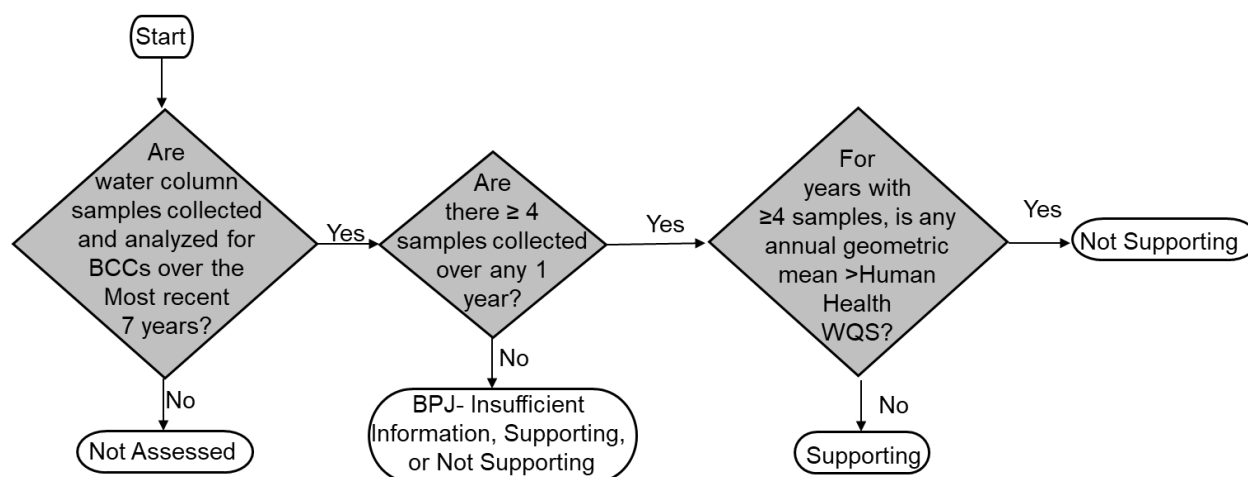


Figure 3.4b. Determination of fish consumption designated use support using water column concentration for BCCs other than Mercury and PCBs.

3.8.2 Assessment Type: Other Public Health Indicators

The MDHHS bases their “Eat Safe Fish” Guidance (advisory) on fish tissue contaminant data collected as part of the Michigan Fish Contaminant Monitoring Program. The fish tissue value is not an ambient WQS; however, EGLE considers the use of the MDHHS advisory based on fish tissue data as appropriate for determining fish consumption designated use support. For example, a fish consumption advisory due to PCBs on a water body specific basis occurs when the upper 95% confidence limit on the mean total PCB concentration in fillet samples of any species exceeds 0.01 mg/Kg (wet weight). The MDHHS has developed advisory screening values for mercury, total PCBs, total DDT, dioxins, toxaphene, selenium, and perfluorooctane sulfonate. Information specific to the MDHHS fish consumption advisory issuance process can be found on the MDHHS [Web site \(www.Michigan.gov/MDHHS/0,5885,7-339-71548_54783_54784_54785-170340--,00.html\)](http://www.Michigan.gov/MDHHS/0,5885,7-339-71548_54783_54784_54785-170340--,00.html).

3.8.2.1 Fish Consumption Advisories for Mercury

As described in Section 3.8.1.1, a fish tissue value of 0.35 mg/kg for mercury is used as the decision point for making nonattainment listing decisions using the previous two years of available tissue data.

3.8.2.2 Fish Consumption Advisories for BCCs and other bioaccumulative substances other than Mercury

For contaminants other than mercury, a water body is considered to not support the fish consumption designated use if the MDHHS has issued a site-specific fish consumption advisory for that water body recommending a consumption rate of 12 meals or less per month. The MDHHS bases their advisories on fish tissue contaminant data collected as part of the Michigan Fish Contaminant Monitoring Program. The fish tissue value is not an ambient WQS; however, EGLE considers the use of the MDHHS advisory listing based on fish tissue data as appropriate for determining fish consumption designated use support. For example, a fish consumption advisory due to PCBs on a water body-specific basis occurs when the upper 95% confidence limit on the mean total PCB concentration in fillet samples of any species exceeds 0.01 mg/kg (wet weight). Information specific to the MDHHS fish consumption advisory issuance process can be found on the MDHHS [Web site \(http://www.michigan.gov/mdhhs/0,5885,7-339-71548_54783_54784_54785-170340--,00.html\)](http://www.michigan.gov/mdhhs/0,5885,7-339-71548_54783_54784_54785-170340--,00.html). The MDHHS is developing advisory screening values for all fish contaminants.

3.9 Designated Use: Public Water Supply

Several specific segments or areas of inland waters, Great Lakes, Great Lakes bays, and connecting channels are designated and protected as public water supply sources [R 323.1100(8)].

3.9.1 Assessment Type: Physical/Chemical

3.9.1.1 Toxic Substances in Water Column

Assessment of public water supply designated use support determination is problematic because the HNV and HCV for drinking water (surface WQS) calculations assumes exposure via the consumption of 2 liters of untreated water per day, but it also assumes exposure via the consumption of 15 grams of fish per day. The majority of human exposure to compounds that are shown to have a potential to bioaccumulate using this exposure scenario would be from the consumption of fish. In other words, based on the process used to develop the HNV and HCV WQS the relative human exposure to a BCC and many non-BCC toxics in surface waters via strictly water consumption is minimal. Currently, Michigan's Part 4 rules do not contain a methodology to derive human health values that protect humans solely for the consumption of 2 liters of untreated surface water per day. However, for compounds that do not have the potential to bioaccumulate (generally, a bioaccumulation factor of 1) the drinking water HNV and HCV WQS can be used directly to assess the public water supply designated use.

Conversely, for compounds where bioaccumulation has been demonstrated to be an important component in human exposure (generally, a bioaccumulation factor >1), a surrogate screening value will be used to assess the public water supply designated use. In these cases, the Maximum Contaminant Levels (MCL) will be used to compare to water column data from an assessment standpoint. The MCLs are used by EGLE's, Drinking Water Program, as the

maximum permissible level of a contaminant in water that is delivered to any user of a public water system. The MCLs are solely based on the consumption of two liters of water and do not include a fish consumption component in the calculation; because of this, it was decided that MCLs were reasonable to use as a screening value for water column comparison for toxics where bioaccumulation makes direct comparison to WQS inappropriate. Because the MCL is a standard applicable after treatment, an exceedance of an MCL will not be used as the basis for a nonattainment determination. Instead, the water body will be assessed as “Insufficient Information” indicating the need for further investigation and additional coordination with EGLE’s, Drinking Water Program, to complete a full assessment.

Data used for public water supply assessments should be reflective of conditions within the Critical Assessment Zone (CAZ) for Great Lakes and inland intakes., as described in Section 3.10, for a particular intake. Similar to the assessment methods used in Section 3.6.1.1, and USEPA guidance, a minimum of four annual data points are generally used to assess toxic substances following Figure 3.5 (USEPA, 2002). The geometric mean of ambient water sample results from a CAZ will be compared to either the WQS or the MCL, as appropriate following the process in Figure 3.5. Geometric mean is chosen to help interpret the surface water data for WQS or MCL comparison because these levels are based on long-term exposure of humans to surface water for drinking. In rare instances, limited data (less than 4 data points) demonstrating extreme exceedance of WQS may be used to assess a water body as not supporting the public water supply designated use; if so, the basis for these decisions will be reflected in ATTAINS.

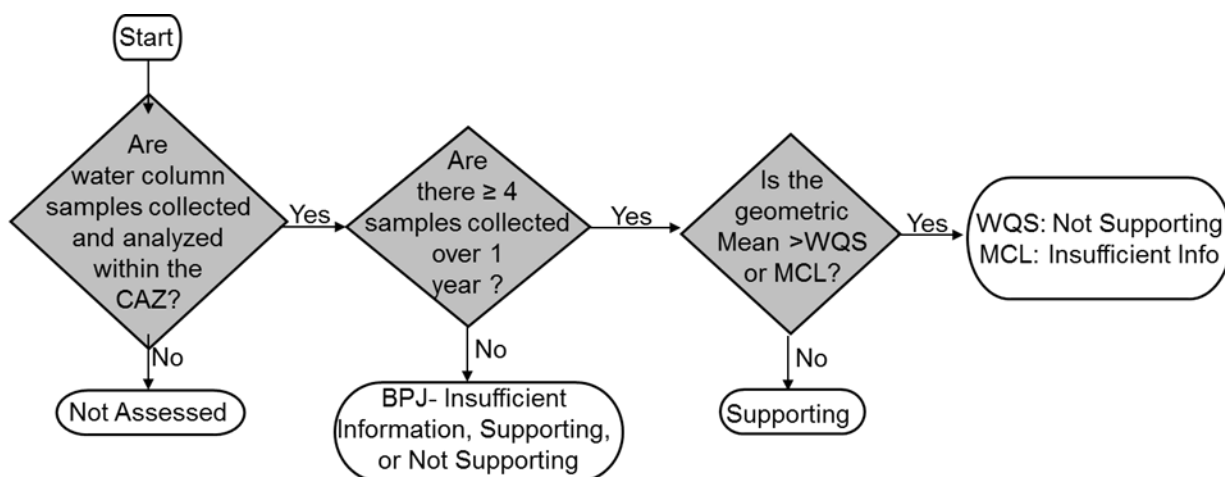


Figure 3.5. Determination of the public water supply designated use support using WQS or MCLs.

3.9.1.2 Chlorides

Designated use support determination using chlorides data is made on a case-by-case basis where one or more representative monthly average calculations can be made and compared to R 323.1051(2). With consistent ambient monitoring data (e.g., ambient drinking water intake data) the WQS will be considered not supporting the public water supply designated use if more than 10 percent of samples during the period of review exceed the applicable WQS.

3.9.1.3 Taste and Odor

To determine public water supply designated use support, site-specific complaints of taste and odor causing substances in community source waters are considered on a case-by-case basis.

3.9.1.4 Nitrates

Elevated nitrates in drinking water source water can lead to acute health concerns, particularly in infants. The nitrate WQS and MCL are both 10 mg/L to be protective of methemoglobinemia in infants. Nitrate data used for public water supply assessments should be reflective of conditions within the Critical Assessment Zone (CAZ) or inland 12-digit HUC and relevant additional waters, as described in Section 3.10, for a particular intake. Similar to the assessment methods used in Section 3.6.1.1, a minimum of four annual data points are generally used to assess nitrate conditions in surface waters as supporting the public water supply designated use. However, due to the acute nature of the health impacts, one or more exceedances of the 10 mg/L WQS will lead a not supporting assessment.

In rare instances, limited data (less than 4 data points) demonstrating extreme exceedance of WQS may be used to assess a water body as not supporting the public water supply designated use; if so, the basis for these decisions will be reflected in ATTAINS.

3.9.1.5 Total Microcystins

The relationship between microcystins and their environmental drivers is complicated and not well understood. From a public water supply assessment standpoint in Michigan, the understanding of expectations for natural background concentrations, the susceptibility of surface water drinking water intakes to microcystins, and expectations for conventional treatment efficacy need to be more fully explored. Although the presence of microcystins in source water may necessitate additional treatment from a SDWA program standpoint, the link between that need and the presence of total microcystins in source water that indicates something unnatural and caused by a pollutant may not be clear in many cases.

The USEPA developed health advisory (HA) levels for total microcystins in finished drinking water in 2015. While non-regulatory, these HA levels serve as guidance and provide concentrations at or below which adverse health effects are not anticipated over a 10-day duration. Two HA levels were developed, one (1.6 ug/L) for school-age children through adults and one (0.3 ug/L) for pre-school age children under six years old. Practically speaking, the more conservative HA level of 0.3 ug/L offers a level at which the entire population is protected. These HA levels are important in providing meaningful targets for SDWA programs from a treatment perspective.

The presence of microcystins in drinking source water, while treatable, often presents the need for water treatment facilities to upgrade from conventional treatment to address a source water quality problem. The detection of microcystins in raw intake water above the HA level indicates that, without additional treatment, the source water body may not provide suitable potable water. However, the ability to differentiate between possibly naturally occurring occasional total microcystins from those caused or exacerbated by pollutants, differentiates between possible assessments for the PWS use from a surface water standpoint. It should be noted that the designated use assessment has no bearing on the decisions made in the SDWMA program regarding the need to provide additional treatment to protect human consumption.

There are no cyanotoxin water quality criteria for the protection of the public water supply designated use. However, the public water supply designated use may be assessed with a combination of total microcystins monitoring data in raw source water and information on the condition of that water body in the vicinity of the intake related to nutrient inputs and other indications of source water quality issues (e.g. documented blooms of algae or cyanobacteria, observed scums, elevated chlorophyll-a). To assess the public water supply designated use total microcystins data should be gathered monthly, at a minimum, during the growth season (June through September).

In cases where two or more total microcystins results in surface water exceed the more conservative HA level of 0.3 ug/L in a 3-year period and are supported by documented eutrophication and nuisance nutrient conditions in the same 3-year period (see Section 3.6.2.2) that are likely causative, an assessment of Not Supporting the use may be made. Exceedance of the HA level must be at least 30 days apart to reflect cyanotoxin events that are either repeating frequently, or substantial in duration.

In rare circumstances, BPJ may be used to assess a water for the public water supply designated use based on different 'weight-of-evidence' scenarios. Equally rare, the presence of total microcystins alone, particularly with limited monitoring data and no context relative to other nutrient expression, may result in an assessment of Insufficient Information until additional support linking those concentrations to conditions related to human impacts on the water body.

3.10 Assessment Units and Determination of Geographic Extent

Michigan uses the NHD coding scheme (1:24,000 resolution) to georeference water bodies when generating the Sections 305(b) and 303(d) lists. As a base assessment unit, Michigan uses 12-digit HUCs (Appendix A). The geographic extent of a designated use support determination for each water body is made on a case-by-case basis. The 12-digit HUC base assessment unit is used as a default when listing streams and rivers to facilitate record keeping and mapping. Each 12-digit HUC base assessment unit may be split into multiple assessment units if site-specific information supports a smaller assessment unit (e.g., contextual information such as land use, known areas of contamination, point source pollution location, specific fish consumption advisory geographic information, barriers such as dams that restrict fish migration, etc.). An assessment unit may consist of all water bodies in a 12-digit HUC (as a maximum) or specific stream segments or lakes in a 12-digit HUC.

Beyond using the 12-digit HUC as a base assessment unit, contextual information is considered when making a determination of the geographic extent that data collection points represent. For example, if a macroinvertebrate community survey conducted in the lower reach of a branch of a river indicates support of the other indigenous aquatic life and wildlife designated use and a second survey conducted farther upstream (several 12-digit HUCs upstream) in the same river branch also indicates designated use support, then contextual information may be considered to make a determination that the spanned river miles also support the designated use. In this example, contextual information may include similar physical habitat, similar land use, absence of point sources, absence of contaminated sites, etc. Similarly, if an intensive riverine *E. coli* monitoring is conducted, the results from that study may be applied to adjacent assessment units if supported by additional information like land use and more reduced *E. coli* grab sampling data. In other words, if contextual information indicates that it is appropriate, data collected from an assessment unit may be used to make designated use determinations for surrounding water body segments in different assessment units that lack data.

For public water supply intakes that are located in the Great Lakes or connecting channels, a concept of a CAZ around each intake was developed based on a Sensitivity Factor calculated for each intake. The two attributes used to develop the Sensitivity Factor are the water depth above the intake structure and the perpendicular distance from shore or length of the intake pipeline. Other factors such as localized flow patterns, thermal effects, wind effects, lake bottom characteristics, benthic nepheloid layers, etc., may be used to complete the sensitivity analysis. A radius for the CAZ, ranging from 3,000 feet for the most sensitive intakes to 1,000 feet for the least sensitive intakes, is assigned based on the Sensitivity Factor. A shape with this radius is then drawn around the intake to illustrate the CAZ. If the CAZ intersects the shoreline, then the geographic extent of the assessment unit is determined on a case-by-case basis as the most influential 12-digit HUCs that are along the shoreline within the CAZ. For intakes that are located in open waters of the Great Lakes where the CAZ does not intersect the shoreline, the geographic extent of the assessment unit is 1.5 square miles.

For the public water supply designated use in inland intakes, the geographic extent of the assessment unit is the CAZ; calculated as a 3,000 foot radius for all inland intakes.

Ultra low-level PCB monitoring conducted by the EGLE indicates that PCB concentrations exceed the HCV WQS (0.026 ng/L) in all waters sampled. Based on these results, all river miles in the individual watersheds sampled for PCBs are listed as not supporting the fish consumption designated use for PCBs in the water column.

The geographic extent of some beaches is not currently available. In these instances, a geographic extent of 0.2 shoreline miles was used as a default value.

Streams and rivers are listed in terms of miles. Wetlands are listed in terms of acres. Generally, inland lakes are listed in their entirety as acres, and Great Lakes and bays are listed in terms of square miles, except for Great Lake and inland lake beaches, which are listed in terms of shoreline miles for pathogen concerns.

3.11 Assessment Unit Assignment to Categories

After support determinations for all designated uses and geographic extent decisions are made for an assessment unit, categories are assigned using a multiple category system. The following categories and subcategories are used:

Category 1: All designated uses are supported, no use is threatened.

Category 2: Available data and/or information indicate that some, but not all of the designated uses are supported; the remainder are either not assessed or have insufficient data to make a support determination.

Category 3: There is insufficient available data and/or information to make a designated use support determination.

Category 4: Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.

Category 4a: A TMDL to address the impairment-causing pollutant has been approved or established by the USEPA.

Category 4b: Other approved pollution control mechanisms are in place and are reasonably expected to result in attainment of the

designated use within a practical time frame.

Category 4c: Impairment is not caused by a pollutant (e.g., impairment is due to lack of flow or stream channelization).

Category 5: Available data and/or information indicate that at least one designated use is not being supported or is threatened, and a TMDL is needed.

An assessment unit is considered threatened and is placed in Categories 4 or 5 when water quality data analysis demonstrates a declining trend that is expected to cause that water body to not attain WQS by the next listing cycle (2022). An assessment unit is not attaining WQS when any designated use is not supported (i.e., Category 4 or 5). Assessment units placed in Category 5 form the basis for the Section 303(d) list and the TMDL development schedule (see Chapter 8 for additional information regarding TMDLs).

Statewide TMDLs have been developed for PCBs and mercury and approved by the USEPA. It is anticipated that future assessments involving PCB or mercury data determined to be atmospheric in source (vs. an otherwise locally controllable source from legacy contamination or point-source conditions) will be assigned to Category 4a based on the existence of the approved statewide TMDLs. More information on this process is described in both the statewide PCB and mercury TMDLs.

A few instances exist where the EGLE has determined that assessment units do not support one or more designated uses, but other appropriate pollution control mechanisms are in place. These assessment units are placed in Category 4b. As described above, the pollution control mechanism for a Category 4b water body is expected to result in the attainment of the designated use within a practical timeframe. Considerations to determine if a pollution control mechanism is appropriate to place a water body in Category 4b include, but are not limited to: the scale of the project (e.g., geographic extent affected, duration, etc.) and the anticipated level of impact on water quality. The EGLE works closely with the USEPA to develop any new listings in Category 4b.

Assessment methodologies used for streams and rivers are also used for channelized streams, when appropriate, including rapid bioassessment of macroinvertebrate and fish communities according to the five-year rotating watershed cycle.

An assessment unit is listed in Category 4c when sufficient water quality data and information are available to determine all the following:

- A specific designated use is not supported (e.g., the other indigenous aquatic life and wildlife designated use is not supported based on a P51 poor macroinvertebrate community rating).
- The cause of the designated use nonattainment is due to something other than a pollutant (e.g., channel maintenance activity or beaver dam).
- No pollutant would cause the designated use nonattainment if the above cause did not occur.

Assessment units are only placed in Category 4c when EGLE monitoring staff determines (using P51 or other appropriate techniques) that sufficient water quality data and information are available to clearly indicate that the Category 4c listing requirements explained in the preceding paragraph fully apply.

Key factors considered by EGLE monitoring staff to help differentiate whether pollutants or other causes are responsible for the observed nonattainment include: water/sediment chemistry and microbiological data when such data are available for the assessment unit, riparian land use characteristics, and P51 habitat metric scores, particularly those for the epifaunal substrate/available cover, embeddedness, sediment deposition, channel alteration, channel sinuosity, bank stability, bank vegetative protection, and riparian vegetative zone width metrics.

It should be noted that EGLE recognizes sediment to be a pollutant. If EGLE aquatic biologists determine that a pollutant (including riparian sediment) is responsible for an assessment unit not supporting a designated use, then that assessment unit is listed in Category 5. Additionally, if channel modification activities in an upstream assessment unit result in sedimentation problems in a downstream assessment unit to a point which causes a designated use to not be supported, then that downstream assessment unit is listed in Category 5.

Michigan uses a multiple category system; therefore, placement of an assessment unit in Category 4c based on a determination that a designated use is not supported and the cause is not a pollutant does not preclude placement of that assessment unit in Category 5 (or any other category) based on a designated use support determination for a different designated use.

Assessment units that do not support a designated use due to multiple causes may be listed in multiple categories for that designated use. For example, an assessment unit may have a TMDL completed for sedimentation; therefore, the assessment unit is listed in Category 4a for the other indigenous aquatic life and wildlife designated use. The same assessment unit may have a mercury TMDL scheduled but not yet completed; therefore, the assessment unit is also listed in Category 5 for the other indigenous aquatic life and wildlife designated use (see Table 3.3, Assessment Unit 10). In this case, the assessment unit is reported in both Categories 4a and 5 for the other indigenous aquatic life and wildlife designated use.

The following example (Table 3.3) adapted from USEPA guidance, illustrates Michigan's use of a multiple category system.

Table 3.3. Examples of assessment unit assignment to categories using a multiple category system with three designated uses. S = Supporting, NS = Not Supporting, - = Not Assessed, ? = Insufficient Information, / = Designated use does not apply to assessment unit.

	Designated use A	Designated use B	Designated use C	Assigned Categories
Assessment Unit 1	S	S	S	1
Assessment Unit 2	NS	NS	NS	5
Assessment Unit 3	S	S	-	2, 3
Assessment Unit 4	S	S	?	2, 3
Assessment Unit 5	S	-	?	2, 3
Assessment Unit 6	S	NS (nonpollutant)	S	2, 4c
Assessment Unit 7	S	?	NS	2, 3, 5
Assessment Unit 8	S	NS (nonpollutant)	/	2, 4c, 3*
Assessment Unit 9	-	NS (TMDL approved)	NS	3, 4a, 5
Assessment Unit 10	-	NS (TMDL approved) NS	-	3, 4a, 5

* Currently designated uses that do not apply to an assessment unit are assigned not assessed in ATTAINS (e.g., coldwater fishery).

Justification for designated use support determination for each assessment unit is contained in ATTAINS. A comprehensive list of designated use support determinations is provided in Appendix B.

3.12 Impairment Cause and Source

When a determination is made that a designated use is not supported (i.e., an assessment unit is placed in Category 4 or 5), the cause and source of impairment are identified. Generally, the cause of impairment is the parameter(s) used to determine that the designated use is not supported unless a biological indicator is used. The source of impairment is determined using supporting contextual information and BPJ.

In addition, sediment toxic substance concentration data may be used to support other assessment types to make support determinations for the other indigenous aquatic life and wildlife, fish consumption, or other designated uses. Sediment data are collected from water bodies when there is direct knowledge or reasonable expectation of heavy metal or organic chemical contamination at levels that may impair biological communities by direct toxicity or cause fish consumption problems. Contaminated sediments may be listed as the source of impairment when sediment pollutant concentrations exceed screening concentrations (MacDonald et al., 2000; Jones and Gerard, 1999; and Ontario Ministry of the Environment, 1993) or when sediment toxicity test results demonstrate excessive toxicity.

3.13 Delisting Category 5 Assessment Units

Assessment units are removed from the Section 303(d) list (i.e., moved from Category 5 to another category) by EGLE using representative data and the current assessment methodology. Data analysis used to remove an assessment unit from the Section 303(d) list must be at least as rigorous a data analysis as was originally used to list the water body. Specific instances that justify the removal of assessment units from Category 5 include:

- A TMDL has been developed for all pollutants and approved by the USEPA (assessment unit is placed in Category 4a).
- A corrective, remediation action plan has been approved to be implemented or the problem source(s) has been removed, thereby, eliminating the need for a TMDL (assessment unit is placed in Category 4b or when water quality is reevaluated and it is determined that the designated use is supported, the assessment unit is placed in Category 2 or Category 1).
- The source of impairment for the initial designated use support determination was an untreated Combined Sewer Overflow (CSO) and updated information reveals that the untreated CSO has been eliminated or control plan elements have been implemented in a legally binding document that includes a schedule for elimination of the untreated discharge but data are not yet available to document restoration (assessment unit is placed in Category 3 unless the corrective action program has not yet been completed, then it is placed in Category 4b).
- Reassessment of the assessment unit using updated monitoring data or information, techniques, or WQS, indicates that the water body now supports the designated use (assessment unit is placed in Category 1 or Category 2).

- Reexamination of the monitoring data or information used to make the initial designated use support determination reveals that the decision was either incorrect or inconsistent with the current assessment methodology.
- Reassessment of a water body indicates that the cause of impairment is not a pollutant (assessment unit is placed in Category 4c).
- The assessment unit is determined to be within Indian Country, as defined in 18 U.S.C., Section 1151. These water bodies are not considered waters of the state of Michigan, and therefore, are not appropriate to include on the Section 303(d) list.

3.14 Assessment Methodology Changes

In addition to the minor edits and clarification changes made to update the 2018 assessment methodology for the 2020 IR, the following updates were made under the noted Sections:

3.5.1.1- Dissolved Oxygen methodology for assessing fish communities in Inland Lakes has been expanded to provide more specific guidance on the kinds of data needed for assessments and how those will be made.

3.5.2.1 – Additional guidance is provided for assessing fish communities in coldwater lakes using indicator species data from various methods in combination with oxythermal profile data.

3.6.1.2 – Additional lines of evidence and decision thresholds for assessing nutrient expression in inland lakes were added.

3.6.2.2 - Additional lines of evidence and decision thresholds for assessing nutrient expression in inland lakes were added.

3.6.2.3 - Figure 3.2 was edited to include steps for an evaluation process when there are no sediment toxicity tests available, but there are sediment chemistry results relevant to the assessment unit.

3.10 – The geographic extent for the assessment unit for inland public water supply intakes was clarified to be consistent with the CAZ approach used in the Great Lakes.

CHAPTER 4

ASSESSMENT RESULTS: THE GREAT LAKES, BAYS, CONNECTING CHANNELS (ST. MARYS, ST. CLAIR, AND DETROIT RIVERS), AND LAKE ST. CLAIR

4.1 Trophic Status

Overall phosphorus loading reductions in the Great Lakes are attributable, in part, to effluent nutrient limits in NPDES permits issued to municipal and industrial facilities. For Great Lakes protection, Michigan's WQS restrict point source discharges of phosphorus to 1 milligram per liter (mg/L) as a maximum monthly average. Lower limits may be, and often are, imposed to protect designated uses in receiving or downstream waters.



Legislation passed in 1977 that reduced the allowable phosphorus content in household laundry detergents sold in Michigan to less than 0.5% phosphorus by weight has contributed to the reduction of phosphorus discharged from point sources. Legislation passed in 2009 reduced the allowable phosphorus content in any cleaning agent sold in Michigan intended for use in household clothes washing machines and, beginning July 1, 2010, dishwashers to 0.5% by weight expressed as elemental phosphorus. This legislation has the effect of further reducing phosphorus loads from wastewater treatment plants and on-site treatment systems. NPS phosphorus reduction efforts continue and are aided by legislation that went into effect in 2012 banning the use of phosphorus-containing lawn fertilizers. The current trophic status of each of Michigan's Great Lakes is presented in Table 4.1.

Table 4.1 Trophic status of the Great Lakes bordering Michigan.

Lake	Trophic Status (nutrient level)
Superior	Oligotrophic* (low)
Huron	Oligotrophic* (low)
Saginaw Bay	Eutrophic† (high)
Michigan	Oligotrophic* (low)
Erie (Central Basin)	Oligotrophic/mesotrophic* (moderate)
Western Basin	Mesotrophic* (moderate)

*USEPA, 2015; †USEPA, 2011

4.2 Water Chemistry of the Great Lakes Connecting Channels

Quality assured data through 2017 were used for assessment updates for this reporting cycle. Refer to discussions of broader trends and results around Michigan as analyzed in the most recent WCMP report (EGLE, 2019b).

4.3 Water Chemistry of Saginaw Bay and Grand Traverse Bay

Quality assured data through 2017 were used for assessment updates for this reporting cycle. Refer to discussions of broader trends and results around Michigan as analyzed in the most recent WCMP report (EGLE, 2019b). Saginaw Bay and Grand Traverse Bay monitoring efforts continue and will continue to be summarized in periodic reports with connecting channels (see Section 4.2) and rivers and streams (see Section 6.2).

4.4 Fish Contaminants

Several projects have been implemented in the Great Lakes basin to monitor temporal and spatial trends in fish contaminant levels:

- The USEPA, Great Lakes National Program Office, collects and analyzes whole lake trout from the open waters of Lakes Superior, Michigan, Huron, and Ontario, and walleye from Lake Erie.
- Michigan's whole fish contaminant trend monitoring effort, initiated in 1990, focuses on fish collected from ten fixed stations located in the Great Lakes bays and connecting channels.

In addition, edible portion fish tissue contaminant monitoring was conducted in 2016 and 2017 from 6 locations in Michigan's Great Lakes and Connecting Channels. Notable findings from these recent results include:

- PFOS concentrations in fish tissue samples from Lake Superior, the St. Clair River, and Lake St. Clair resulted in fish consumption advisories, thereby causing those water bodies to be listed as impaired by PFOS for the fish consumption designated use. Important to note, Lakes Michigan and Huron were listed as impaired by PFOS in fish tissue in the 2016 IR based on fish tissue monitoring as well (Figure 4.1).
- Toxaphene was identified as a cause of impairment based on concentrations in fish tissue found in Lake Superior samples.
- Broadly, PCBs and dioxins cause restricted consumption advisories for certain species of gamefish. Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access.

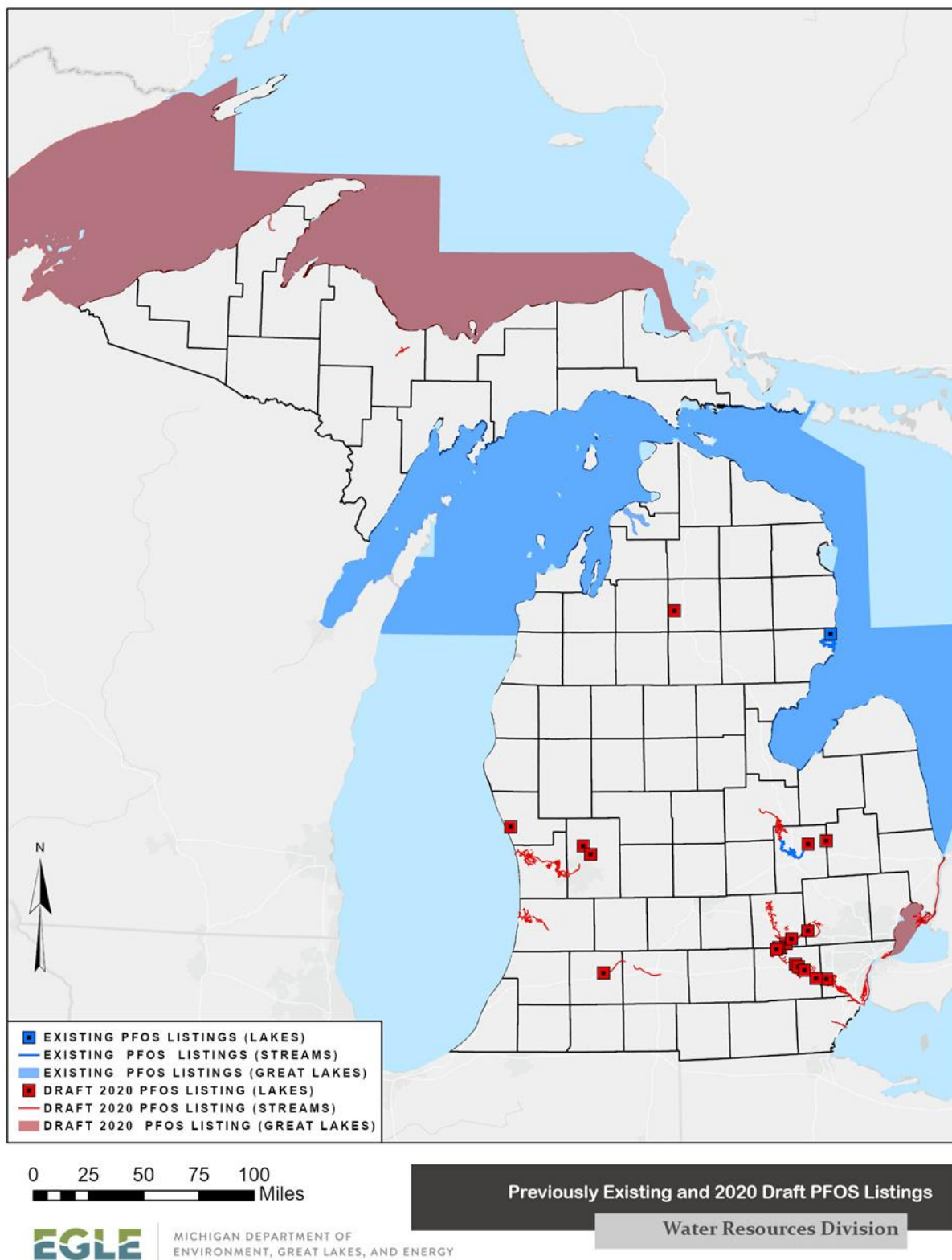


Figure 4.1. Existing and Draft Fish Consumption Impairments based on PFOS in Fish Tissue data.

4.5 Contaminated Sediments

Following the development of new assessment methods in the 2018 IR incorporating sediment chemistry and bulk sediment toxicity data, this 2020 IR assessment includes the use of these data to assess portions of Lake Superior near the town of Gay, Michigan, along the eastern shoreline of the Keweenaw peninsula for impact from historic mining stamp sand deposits and subsequent erosion and movement. Monitoring data from WRD and Remediation and Redevelopment Division programs conducted in 2008 and 2006, respectively, were used to combine in-lake sediment chemistry and bulk sediment toxicity data to demonstrate the impacts that migrating stamp sands are having on the benthic community. The impairments demonstrated by these data were combined with information on substrate stamp sand composition research by Michigan Technological University to aid in delineating the region estimated to be impacting aquatic life (Figure 4.2).

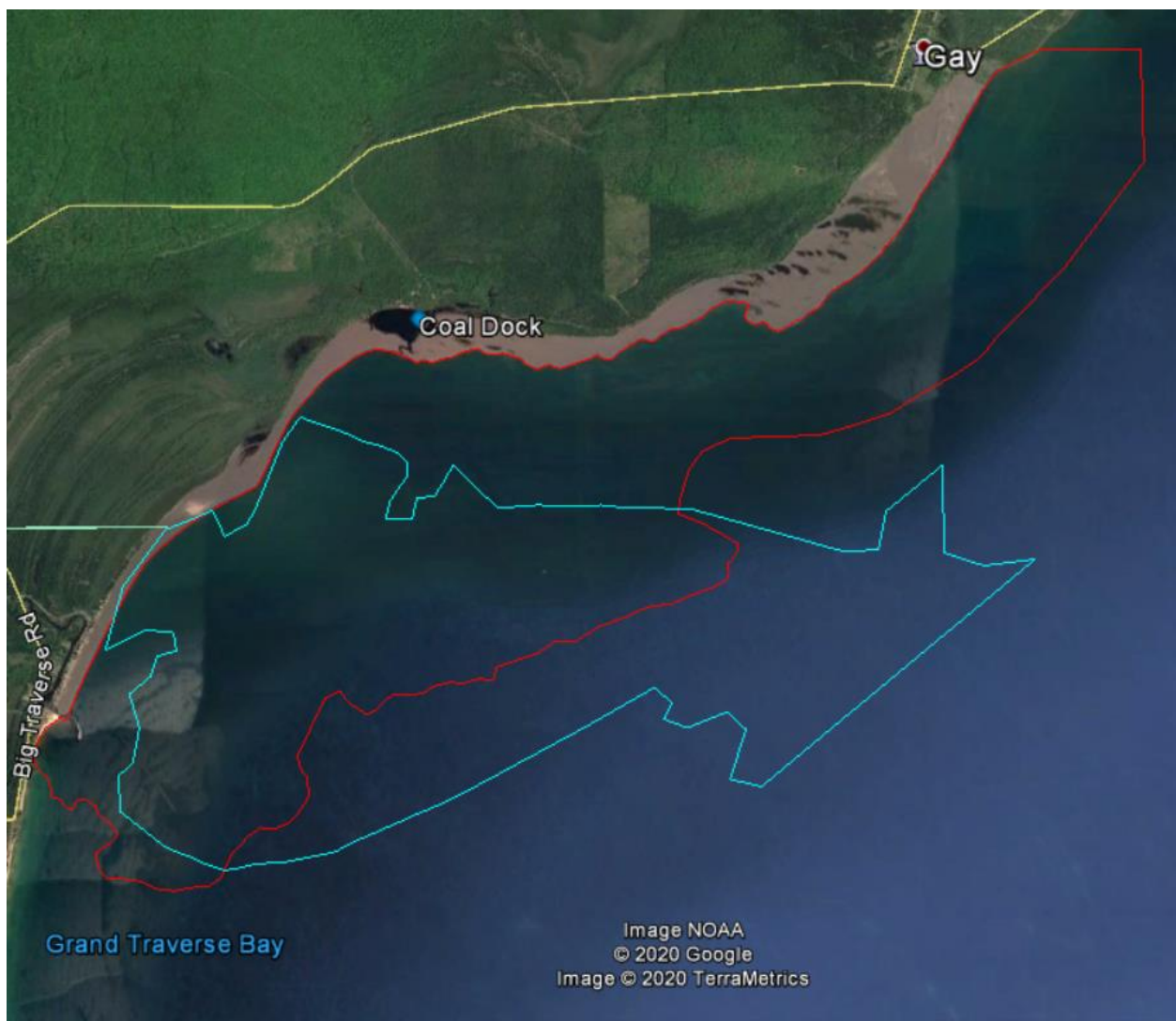


Figure 4.2. Proposed area (outlined in red) for impairment based on stamp sands migration in the vicinity of Gay, Michigan and the Buffalo Reef (outlined in blue).

Additionally, a similar process was used to assess portions of the Rouge River based on sediment chemistry and bulk sediment toxicity resulting in impairments for the Evans Ditch and Tamarack Creek tributaries of the Rouge River near Southfield, Michigan.

4.6 *E. coli*

In 2017, 190 public beaches (owned by a city, county, etc.) on the Great Lakes and Connecting Channels were monitored and 146 reported no exceedances of the *E. coli* WQS for total body contact. There were 44 beaches that reported a total of 87 exceedances.

In 2018, 214 public beaches were monitored and 158 reported no exceedances of the *E. coli* WQS for total body contact. There were 56 beaches that reported a total of 110 exceedances.

The Michigan Beach Web site (<http://www.deq.state.mi.us/beach>) provides access to a database containing beach closings and *E. coli* data collected by local health departments (LHD) and annual reports summarizing the data. Currently, although 620 public beaches located along the Great Lakes are listed in the database, all are not monitored. Data for Great Lakes beaches in Michigan are also available at <http://watersgeo.epa.gov/beacon2/>.

4.7 Decaying Organic Matter Deposits and Nutrients

While recent high water conditions throughout the Great Lakes appear to have resulted in reduced buildups of material, deposits of dead and decaying organic matter continue to periodically foul beaches along Michigan's Great Lakes shoreline including, but not limited to, Grand Traverse Bay, Saginaw Bay, and western Lake Erie, as well as along portions of Michigan's Lake St. Clair shoreline. While increased aquatic vegetation growth is typically associated with elevated nutrient concentrations, shoreline deposits can occur where ambient phosphorus and nitrogen concentrations are very low or declining. Similar problems are being reported along the Wisconsin Lake Michigan shoreline, the Ohio and Pennsylvania Lake Erie shoreline, and the New York Lake Ontario shoreline, where, like Michigan, shorelines are being fouled by decaying organic matter that may interfere with the enjoyment of beaches and nearshore waters.

Once thought to be caused primarily by the presence of excessive nutrients (phosphorus), there is growing evidence that increased organic matter deposits along some shoreline areas may be the result of a complex interaction between nutrients and exotic mussel species (Hecky et al., 2004), the expanding range of filamentous benthic cyanobacteria (e.g., *Lyngbya wollei*) (Bridgeman and Penamon, 2010), changes in wind patterns over the Great Lakes (Waples and Klump, 2002), and fluctuating water levels (Harris, 2004). Research is ongoing to identify the causes and sources for these shoreline deposits with the hope that effective solutions can be found, although indications are that ecosystem shifts based on invasive and nuisance species and climate changes make effective control on a meaningful scale difficult. While phosphorus concentrations may not be solely responsible for all shoreline deposits, programs and policies intended to reduce phosphorus as a significant driver in all waters of the state remain important components of efforts to improve and protect water quality.

The WQS (Rule 323.1050) require that Michigan's surface waters not have any "deposits" in "unnatural quantities which are or may become injurious to any designated use." Deposits of decaying organic material occur naturally in all aquatic systems, and are frequently observed along the Great Lakes and inland lakes, particularly in areas with intact coastal wetlands and marshes; a process necessary at some level to sustain those valuable resources similar to leaf litter maintaining healthy forest soils. It is the difference between natural and exacerbated processes that forms the core of the decision when reviewing available information.

A careful evaluation of available data and scientific information, and a comparison against WQS reveals there is insufficient information to determine whether designated uses are not supported as a result of the decaying organic matter. Additionally, the assessment methods to use organic matter as potential indicators of the recreational use support has not been fully investigated and developed. Consequently, 142 miles of Saginaw Bay and 37.5 miles of western Lake Erie shoreline are listed as having insufficient information to determine support of the total and partial body contact recreation designated uses. In addition, 1,147 square miles of Saginaw Bay are listed as having insufficient information to determine support of the other indigenous aquatic life and wildlife designated use related to nutrients. Recent efforts by NOAA in developing satellite imagery analysis for algae bloom tracking in Saginaw Bay is anticipated to be instrumental in the ability to assess nutrient expression on a bay-wide scale.

Additionally, since 2016, EGLE has been sampling water, including the algal toxin microcystin, and documenting shoreline conditions at beaches along Saginaw Bay to better understand the geographic scope, frequency, and duration of possible nutrient-related impacts to the bay and its shoreline areas (e.g., nearshore attached algae, beach/shoreline 'muck,' and possible Harmful Algal Bloom impacts). Four beaches were monitored from 2016 to 2017 and this effort expanded to 10 beaches or shoreline areas starting in 2018 for a more extensive understanding of the entire bay. It is anticipated that these data will be useful in reassessing the Saginaw Bay shoreline during the 2022 IR cycle.

Designated Uses and Beneficial Uses – Saginaw Bay AOC Example

What's in a name? Confusion is understandable around differences between Designated Uses (as defined under the Part 4 Water Quality Standards; see Section 1.1) and Beneficial Uses used by the AOC Program (under the binational Great Lakes Water Quality Agreement; see www.Michigan.gov/AOCProgram). While the terms sound similar, the processes to define them, and assess their support or impairment can be very different and often results in confusion. An example of this are the apparent 'disconnects' between AOCs with identified Beneficial Use Impairments (BUI) but with similar Designated Uses with potentially differing assessments.

A specific example can be found in the Eutrophication or Undesirable Algae BUI in the Saginaw Bay/River AOC, while a final assessment decision related to potential nutrient impacts on Designated Uses continues to be investigated. The BUI process, started in 1987, often used broad approaches to identify problems within AOCs, using EGLE staff's scientific judgement in consultation with the respective Public Advisory Councils to focus first on identifying concerns and only much later developing specifics related to how to measure restoration success.

Conversely, the Designated Use assessment process takes a different approach, using monitoring data explicitly linked to thresholds identified either as criteria in Rule, or linked as indicators through assessment methods to identify both magnitude of exceedances, frequency, and duration to identify impairments. The need to satisfy a burden of proof for demonstrating impairment or support are rigorous under the Water Quality Standards and consider approaches that are broadly applicable to issues potentially state-wide, a fairly robust process once developed, but also a potentially difficult one particularly when the thresholds in Rule are narrative and thus in need of science-based interpretation. In contrast, the AOC program's ability to identify local concerns and direct efforts to address those at a regional scale means that the reasons for initially identifying BUIs may not perfectly dovetail with Designated Use assessment processes.

Neither is more 'correct', but the challenge is for both programs to be complementary and supportive of the collective goals of water quality restoration and protection.

4.8 Lake Erie Support Summary

Widespread and persistent cyanobacteria blooms in the western basin of Lake Erie continue to affect related designated uses in Michigan's portion of the lake. In 2016 the other indigenous aquatic life and wildlife use was listed as impaired based on repeated, persistent, and extensive cyanobacteria blooms indicating excessive/nuisance nutrient conditions leading to ecological imbalance. Similarly, the 2018 review brought an impairment designation for the public water supply use in portions of Lake Erie, which are critical assessment zones for drinking water intakes, following the relevant assessment methodology (Chapter 3, Section 3.9.1.5).

The significance of the cyanobacteria bloom issue in Lake Erie is evidenced by the Great Lakes Water Quality Agreement Annex 4 (Nutrients) workgroup, including representatives from the

State of Michigan, focusing first and foremost on the Lake Erie issues of algal community imbalance, cyanotoxins, hypoxia, and maintenance of trophic conditions. There is broad agreement that excessive nutrients are the primary cause, from a pollutant perspective, of these changes to Lake Erie's ecosystem. As such, total phosphorus has been identified as the target nutrient for necessary reductions, with the acknowledgement that other relevant nutrients (particularly bioavailable phosphorus forms and nitrogen sources) will also be reduced concomitantly.

The Annex 4 Objectives and Targets Task Team was charged with identifying target reductions to achieve a level of algal growth that supports a healthy and productive Lake Erie, acknowledging that the complete elimination of algae is not in keeping with a healthy aquatic ecosystem. Load reductions were set using the 2004 and 2012 cyanobacteria blooms as the targets at, or below which, future blooms should be maintained 90% of the time. Similarly, it is anticipated that success at eliminating nuisance cyanobacteria bloom conditions will be demonstrated within Michigan waters of Lake Erie based on evaluation of future conditions aligning with the goals identified by the Task Team.

The Annex 4 Objectives and Targets Task Team Final Report (May 11, 2015) went through a significant deliberative process to identify sources and loading estimates of total phosphorus to Lake Erie. Based on these goals, the subcommittee set the load targets of 40 percent reductions in total phosphorus entering the western basin, including, and of particular relevance for Michigan, a 40 percent reduction in spring total and soluble reactive phosphorus (SRP) from the River Raisin, and a 40 percent reduction in spring SRP from the Maumee River, some headwaters to which are in Michigan. The 40 percent reduction of total phosphorus loads to Lake Erie are expected to be met by 2025, with an interim goal of 20 percent reduction by 2020, as stated in the Western Basin of Lake Erie Collaborative Agreement signed in June 2015 by Michigan's Governor Rick Snyder with Premier Kathleen Wynne of the Province of Ontario and Lieutenant Governor Mary Taylor of Ohio.

The MDARD and MDNR are actively working alongside EGLE to address the algae blooms and nutrient loading to western basin of Lake Erie. Plans from the three state agencies are merged into Michigan's 2018 Domestic Action Plan which, when considered with Domestic Action Plans from other states and Canada, establishes a road map for addressing this problem.

Because of the complexity of the cyanobacteria bloom problem Michigan continues to believe the best approach for solving the issues in western Lake Erie is through the collaborative process established under Annex 4 of the Great Lakes Water Quality Agreement and the Western Basin of Lake Erie Collaborative Agreement as they afford a holistic, multi-jurisdictional perspective that does not exist in a traditional TMDL process. Nonetheless, if the current collaborative processes fail to restore designated use support we recognize that a TMDL or other approach allowed by the USEPA to address impaired waters under the CWA will be required.

Michigan's TMDL schedule is aligned with the TMDL vision process described in Section 8.3.3 and Michigan's 2015 TMDL vision identifies TMDL expectations through 2022. The TMDL vision process will continue in 2022 by establishing the next series of priorities for Michigan's TMDL program; part of this next prioritization will be the evaluation of progress under the collaborative agreements related to Lake Erie. Michigan remains strongly committed to reducing phosphorus loadings to western Lake Erie as outlined in the Domestic Action Plan noted above.

CHAPTER 5

ASSESSMENT RESULTS: INLAND LAKES AND RESERVOIRS

5.1 Trophic Status

Carlson's TSI is used by EGLE to assess and classify Michigan's 730 public access lakes (see Section 1.2.2). This classification system is based on an index derived from a combination of four field measurements: (1) summer Secchi depth (transparency); (2) total phosphorus concentration (epilimnetic); (3) chlorophyll a concentration (photic zone), and (4) macrophyte abundance. The numerical value of the index increases as the degree of eutrophication increases. Historically, inland lake monitoring efforts have been directed toward obtaining baseline data for all 730 public access lakes.



The EGLE and USGS completed a cooperative project in 2010 that sampled 730 public access inland lakes greater than 25 acres as part of the Lake Water Quality Monitoring Assessment Project. The majority (72%) of Michigan's public access lakes that were sampled from 2001 through 2010 have moderate (mesotrophic) or low (oligotrophic) nutrient levels (Table 5.1) (Fuller and Taricska, 2012).

Table 5.1 Trophic status summary of Michigan's public access lakes sampled from 2001 through 2010 (N=730).

Trophic Status	Number of Lakes
Oligotrophic (low nutrients)	129 (18%)
Mesotrophic (moderate nutrients)	399 (54%)
Eutrophic (high nutrients)	174 (24%)
Hypereutrophic (excessive nutrients)	28 (4%)

The development of processes to evaluate additional lines of useful data in assessment methods for inland lakes (see Sections 3.6.1.2 and 3.6.2.2) resulted in the decision to assess 8 inland lakes as impaired, each with a well-supported history of nutrient expression issues. A blend of information including trophic status monitoring showing a history of eutrophic and hypereutrophic conditions; complaints and reports of algae and cyanobacteria blooms; satellite imagery showing bloom conditions; aquatic nuisance control records demonstrating repeated extensive treatments; and SWAS staff's professional experience with nutrient expression at these lakes, were used to find lakes to not support the Other Indigenous Aquatic Life and Wildlife designated use based on nutrient causes. These lakes include: Crockery Lake (Ottawa County), Lake Hudson (Lenawee County), Mona Lake (Muskegon County), Thornapple Lake (Barry County), Lake Ovid (Clinton County), Van Etten Lake (Iosco County), Pontiac Lake (Oakland County), and Loch Erin (Lenawee County). The same assessment process is useful in identifying lakes with limited monitoring data which would benefit from additional sampling to better inform future assessments.

During 2017 and 2018 over 250 lakes were sampled each year as part of the Cooperative Lakes Monitoring Program, under the Michigan Clean Water Corps (for additional information see <http://www.MiCorps.net>). During 2017, 215 of these lakes were sampled for the three primary

trophic status indicators (secchi depth, total phosphorus, and chlorophyll-a). Of these lakes, 156 were classified as oligotrophic, 49 mesotrophic, and 10 eutrophic. During 2018, 261 lakes were sampled for all three primary trophic status indicators and 155 were classified as oligotrophic, 93 mesotrophic, and 13 eutrophic.

5.2 Fish Contaminants

In 1990, Michigan initiated a fixed station fish contaminant trend monitoring project to measure spatial and temporal trends of certain bioaccumulative contaminants. Adult fish are collected from each site at a target interval of two to five years, and analyzed as whole fish samples. Fish have been collected from seven inland lakes (Gogebic, South Manistique, Higgins, Houghton, Gun, Gull, and Pontiac) as part of the fish contaminant trend monitoring project. Whole fish fixed station trend monitoring data collected since 1990 were reviewed and general trend conclusions for inland lakes are summarized below:

- Lindane, terphenyl, PBB, heptachlor, and aldrin were quantified only rarely in the fish sampled. However, heptachlor epoxide and dieldrin (breakdown products of heptachlor and aldrin) were quantified in most of the samples analyzed.
- In addition to heptachlor epoxide and dieldrin, several chemicals were quantified in fish consistently, indicating that they are ubiquitous in the aquatic environment. These include mercury, hexachlorobenzene, total PCB, total chlordane, and total DDT.
- Fish from inland lakes tended to have higher concentrations of mercury than the same species from the Great Lakes or connecting channels.
- Total PCB concentrations declined at all of the inland lake trend sites monitored between 1990 and 2015, with an average decline of 8% per year.
- Total DDT concentrations declined at all of the inland lake trend sites monitored between 1990 and 2015, with an average decline of 7% per year.
- Total chlordane concentrations declined at all of the inland lake trend sites monitored between 1990 and 2015 where a trend could be detected, and the average decline was 8% per year. No trend was detected at 2 inland lakes because chlordane concentrations were consistently below the analytical quantification level.
- Significant trends in mercury concentrations have been detected at 4 of the 7 inland lake trend sites. Mercury concentrations in walleye from Lake Gogebic declined 2% per year between 1991 and 2015, declined in largemouth bass from Gull Lake at a rate of 2% per year between 1991 and 2015, while increasing in South Manistique Lake walleye by 1% per year between 1991 and 2015 and 4% per year in lake trout from Higgins Lake between 1991 and 2015.

In addition, edible portion fish tissue contaminant monitoring was conducted in 2016 and 2017 from 28 inland lakes and reservoirs. Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access. Results of the edible portion monitoring are used by EGLE in determining the status of the fish consumption designated use for a given water body. Noteworthy among these are 19 new fish

consumption designated use impairments based on PFOS in fish tissue (see Figure 4.1). Additionally, Toxaphene was identified as a cause of impairment based on concentrations in fish tissue found in Muskegon Lake samples. The edible portion fish tissue results are also used by the MDHHS to update fish consumption advisories.

5.3 Beaches

In 2017, a total of 192 public beaches (owned by a city, county, etc.) on inland lakes were monitored and 162 had no exceedances of the *E. coli* WQS for total body contact. There were 30 beaches that reported a total of 49 exceedances.

In 2018, a total of 238 public beaches on inland lakes were monitored and 195 had no exceedances of the *E. coli* WQS for total body contact. There were 43 beaches that reported a total of 86 exceedances.

The Michigan Beach Web site (<http://www.deq.state.mi.us/beach>) provides access to a database containing beach closings and *E. coli* data collected by LHDs and annual reports summarizing the data. Currently, 597 public beaches located on inland lakes are listed in the database; although, not all beaches are monitored.

5.4 Water Chemistry

In 2019 EGLE developed aquatic life water quality values for both chloride and sulfate thereby providing additional thresholds to more fully protect life in lakes and streams by being able to assess concentrations of these parameters in waters all around Michigan. Based on these new values, Earl Lake (Livingston County) was found to be impaired for both the Warmwater Fishery and the Other Indigenous Aquatic Life and Wildlife designated uses based on an extensive set of chloride data.

CHAPTER 6

ASSESSMENT RESULTS: RIVERS

6.1 Biological Integrity

All available biological assessments (e.g., fish and macroinvertebrate communities, targeted and probabilistic study designs) are evaluated using the assessment methodology (Chapter 3) and potentially used to determine designated use support. As part of EGLE's water quality monitoring program, sites are selected using both targeted and probabilistic study designs to assess the biological integrity of rivers and streams using macroinvertebrate communities. Procedure 27 (MDEQ, 2015) is used to estimate the number of river miles supporting the other indigenous aquatic life and wildlife designated use. Results from the 2012 through 2016 cycle were combined to determine a statewide designated use support status estimate of 95% for the other indigenous aquatic life and wildlife designated use in Michigan rivers and streams. Results from this project will also be used to assess temporal trends in biological integrity.

Michigan Clean Water Corps volunteers sample stream sites throughout the State of Michigan to assess water quality. During 2017, 194 stream sites were sampled for macroinvertebrate communities and available habitat. During 2018, 191 stream sites were sampled for macroinvertebrate communities and available habitat.



6.2 Water Chemistry

EGLE and its partners collect water samples from many rivers and streams throughout the state as part of the WCMP and other special studies and analyze them for a variety of parameters. Quality assured data through 2017 were used for assessment updates for this reporting cycle. Refer to discussions of broader trends and results around Michigan as analyzed in the most recent WCMP report (EGLE, 2019b).

In 2019 EGLE developed aquatic life water quality values for both chloride and sulfate thereby providing additional thresholds to more fully protect life in lake and streams by being able to assess concentrations of these parameters in waters all around Michigan. Based on these new values, seven stream reaches were found to be impaired for both the Warmwater Fishery and the Other Indigenous Aquatic Life and Wildlife designated uses based on chloride data; these included the Clinton River watershed (Plum Brook and the Clinton River), Rouge River watershed (Fellows Creek and the Rouge River), Belle River (St. Clair County), and the Pigeon River (Ottawa County). Additionally, Plum Creek (Monroe County) was found impaired based on sulfate data.

6.3 Fish Contaminants

In 1990, Michigan initiated a fixed station fish contaminant trend monitoring project to measure spatial and temporal trends of certain bioaccumulative contaminants. Adult fish are collected from each site at a target interval of two to five years and analyzed as whole fish samples. Carp were collected periodically from five river impoundment trend monitoring sites since 1990. These sites were located on the Muskegon, Grand, Kalamazoo, St. Joseph, and Raisin Rivers. Whole fish fixed station trend monitoring data collected between 1990 and 2015 were reviewed and general trend conclusions for rivers are summarized below:

- Lindane, terphenyl, PBB, heptachlor, and aldrin were quantified only rarely in the fish sampled. However, heptachlor epoxide and dieldrin (breakdown products of heptachlor and aldrin) were quantified in most of the samples analyzed.
- In addition to heptachlor epoxide and dieldrin, several chemicals were quantified in fish consistently, indicating that they are ubiquitous in the aquatic environment. These include mercury, hexachlorobenzene, total PCBs, total chlordane, and total DDT.
- Average total PCB concentrations were highest in carp from the Kalamazoo River site. The Kalamazoo River has extensive areas of PCB contaminated sediments, a problem that is being addressed under state and federal programs.
- Total PCB concentrations declined at all 5 river trend sites, with an average decline of 7% per year between 1990 and 2015.
- Total DDT concentrations declined at all but 1 river trend site, with an average decline of 8% per year between 1990 and 2015. The exception was the Grand River site (6th Street Dam impoundment in Grand Rapids) where no trend in DDT in carp was detectable between 1990 and 2014.
- Total chlordane concentrations declined at all 5 river trend sites, with an average decline of 7% per year between 1990 and 2015.
- Mercury concentrations decreased 3% per year in fish from the River Raisin. No significant trends in mercury concentration were measured in the Grand, Kalamazoo, Muskegon, or St. Joseph Rivers.

Edible portion fish tissue contaminant monitoring was conducted in 2016 and 2017 in 19 rivers around Michigan. Edible portion sampling is often targeted toward known sites of contamination, sites popular with sport anglers, and sites with public access. Results of the edible portion monitoring are used by EGLE in determining the status of the fish consumption designated use for a given water body and by the MDHHS to update the fish consumption advisories. Of note, based on the locations monitored in 2016 and 2017, multiple rivers and streams were assessed as not supporting the fish consumption designated use based on PFOS in fish tissue, including the entirety of the Huron River watershed (Figure 4.1).

6.4 Microorganisms

In 2017, a total of 6 public beaches on rivers were monitored and 5 reported no exceedances of the *E. coli* WQS for total body contact. There was 1 beach that reported 1 exceedance.

In 2018, a total of 5 public beaches on rivers were monitored and 4 reported no exceedances of the *E. coli* WQS for total body contact. There was 1 beach that reported 1 exceedance.

The Michigan Beach Web site (<http://www.deq.state.mi.us/beach>) provides access to a database containing beach closings and *E. coli* data collected by LHDs. Currently, 71 public beaches located on rivers are listed in the database.

For the 2020 reporting cycle, EGLE monitored 217 river sites across the state for *E. coli*, including the Grand River and many of its tributaries (Crockery, Maple, Thornapple, and Rogue), Manistee, Kalamazoo, White (Pere Marquette), Rifle, Flint, and tributaries to Lakes Erie and Huron. Conservation districts, health departments, colleges, and local organizations submitted data sufficient for determining use attainment status for an additional 37 riverine sites; including portions of the Pine (Alma, Michigan), Macatawa, and River Raisin. Based on this *E. coli* monitoring by EGLE and others, about 4,860 miles were listed as not supporting the Total Body Contact recreation designated use, and 550 miles of rivers and streams were listed as supporting the use. To view the newly assessed waters, select the “*E. coli* monitoring” tab of the *E. coli* Pollution and Solution Mapper (accessible from <http://www.Michigan.gov/EcoliTMDL>).

CHAPTER 7

ASSESSMENT RESULTS: WETLANDS

7.1 Designated Use Support Summary

Michigan's WQS apply to all surface waters of the state, including wetlands. However, some criteria may not be applicable to wetlands. For example, a highly productive wetland with abundant vegetation in shallow water and high organic content in the sediment may naturally exhibit low dissolved oxygen levels in the water column. Based on Rule 100(10) of the WQS, use attainability studies are allowed for certain wetlands to address this situation.



Michigan's wetlands are currently assessed for designated use support on an as needed basis. Michigan uses a multiple category system (i.e., assessment units may be placed in one or more category, see Section 3.11). Details regarding the listed wetlands follow.

- Tobico Marsh (Bay County), a 680-acre marsh adjacent to Saginaw Bay, is not supporting the fish consumption designated use due to elevated PCB concentrations in carp and northern pike populations. Carp and northern pike were collected and analyzed between 2007 and 2012. These new data did not result in a change to the fish consumption advisory.
- Ruddiman Creek Lagoon (21 acres in Muskegon County) is not supporting the fish consumption, and total and partial body contact recreation designated uses. This wetland was the subject of a major sediment remediation project completed in 2006 that involved the removal of approximately 86,000 cubic yards of sediments contaminated with PCBs, metals, and polynuclear aromatic hydrocarbons.
- Clark's Marsh (Iosco County), a 420-acre marsh adjacent to the Au Sable River, is not supporting the fish consumption designated use due to elevated PFOS in bluegill and pumpkinseed sunfish sampled in 2011. This marsh is adjacent to the former Wurtsmith Air Force Base, an area of which was used regularly for fire suppression training with fire-fighting foams containing perfluorinated compounds.

CHAPTER 8 WATER BODIES NOT SUPPORTING DESIGNATED USES AND CWA SECTION 303(D) REQUIREMENTS

8.1 Introduction

The purpose of this chapter is to provide additional information regarding water bodies that are determined to not support one or more designated uses (i.e., water bodies that are listed in Categories 4 or 5; see Section 3.11 for a description of the categories).

Section 303(d) of the CWA and the USEPA's Water Quality Planning and Management Regulations (40 CFR, Part 130) require states to develop TMDLs for water bodies that are not meeting WQS (i.e., water bodies that are listed in Category 5). The TMDL process establishes the allowable loadings of pollutants for a water body based on the relationship between pollution sources and in-stream water quality conditions. TMDLs provide states a basis for determining the pollutant reductions necessary from both point sources and NPS to restore and maintain the quality of their water resources.



8.2 Impairment Cause and Source

When a determination is made that a designated use is not supported (includes both Categories 4 and 5), the cause and source (when known) of impairment is identified (see Section 3.12). Each assessment unit may be listed for one or more causes and sources of impairment. Summary information on causes and sources statewide are readily available at multiple scales (from statewide down to local subwatershed) from the USEPA's How's My Waterway Web site, newly released in June, 2020 and accessed at <https://mywaterway.epa.gov>. See Section 1.1 for additional information.

8.3 TMDL Development

8.3.1 The TMDL Process

Michigan's Section 303(d) list consists of assessment units that are listed in Category 5 (see Appendix C). A TMDL is developed for each cause (see Section 8.2) or a TMDL may address more than one related cause.

Development of a TMDL is typically preceded by collection of water quality data by EGLE or its contractors to document current pollutant loads within the water body of concern and further define potential sources of the pollutant. These data, in addition to any other relevant information, form the basis for determining the necessary pollutant load reductions. A TMDL document is comprised of several sections including identification of the impaired assessment

unit and cause of impairment, description of water quality studies conducted to identify the extent and source(s) of the impairment, and calculation of necessary load reductions for the point source and NPS to achieve WQS. The TMDL also identifies any past, current, or future known actions to remedy the impairment and a monitoring schedule to track improvements following implementation of the TMDL.

The TMDL document is typically developed by staff members of EGLE. The draft document is made available for public review on EGLE's Web site for at least 30 days. The announcement for the public comment period is published in the EGLE calendar. During the public comment period, EGLE staff normally hold a public meeting in a community near the impaired water body to describe the TMDL and receive comments. Local stakeholders, including the general public, LHDs, local government, and county extension officials are sought to attend the meetings to contribute their expertise in identifying pollutant sources and discuss source reduction/elimination. Following the comment period, the TMDL is modified as appropriate to address comments received.

The TMDL is finalized following the public comment period and submitted to the USEPA, Region 5, for their review and approval. The USEPA has 30 days to review and approve or disapprove a TMDL. After a TMDL is approved by the USEPA, the water body is removed from the Section 303(d) list (Category 5) and reclassified as Category 4a. For additional information regarding delisting Category 5 assessment units see Section 3.13.

8.3.2 TMDLs Completed

In 2014, the EGLE shifted the TMDL focus from the strict pace requirements to the newly-developed Long-term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program. The EGLE developed an approach to TMDL prioritization for the 2016-2022 time period. In 2019 the EGLE statewide *E. coli* TMDL was approved by USEPA. Similarly, in 2019 the USEPA approved the updated Ford Lake and Belleville Lake Phosphorus TMDL, replacing the 2004 version.

Additional information regarding approved TMDLs is available at <http://www.michigan.gov/tmdl>.

8.3.3 TMDL Schedule per Michigan's 2016-2022 Prioritization Framework for the Long-Term Vision for Assessment, Restoration, and Protection Under the Clean Water Act Section 303(d) Program

In December 2013, the USEPA announced the "Long-Term Vision for Assessment, Restoration, and Protection under the Clean Water Act Section 303(d) Program" (TMDL Vision). The TMDL Vision includes six goals: Engagement, Prioritization, Protection, Integration, Alternatives, and Assessment. An evaluation of the accomplishments of the TMDL Vision's goals is to be completed in 2022.

"Prioritization" is defined by the TMDL Vision as a systematic approach developed by individual states to prioritize watersheds or waters for TMDL development, restoration, and protection for incorporation into the 2016 Integrated Report. Once a state identifies its priorities, it will be expected to address all of them between 2016 and 2022 through a combination of TMDLs, alternative approaches, program integration, public engagement improvements, and protection activities. In keeping with this approach, priorities identified in the TMDL Vision document will be assigned a TMDL date of 2022, signifying their anticipated completion by the end of 2022.

Similarly, those TMDLs that were not identified as a priority in this first TMDL Vision document will be assigned a 'low' TMDL priority in ATTAINS, signifying their reevaluation for prioritization during the next TMDL Vision review process. The full TMDL Vision document can be found on the TMDL Web site, available electronically at <http://www.michigan.gov/tmdl>. This document was submitted by the EGLE and agreed upon by USEPA Region 5 in September 2015.

In the past, Michigan did not prioritize TMDLs based solely on watershed location, cause, or pollutant. When a water body was identified as impaired, it was added to the TMDL schedule with a goal of completing a TMDL within 13 years of the first listing (per USEPA guidance). The TMDL schedule published in the 2014 IR ran through 2031. In contrast, the TMDL Vision approach focuses less on TMDL production and more on how the Section 303(d) Program can support water quality objectives of Michigan. Therefore, the TMDL Vision allows the opportunity to better align TMDL priorities with WRD priorities.

In 2009, the WRD identified five major goals to define aspects of this mission: (1) Enhance Recreational Waters; (2) Ensure Consumable Fish; (3) Protect and Restore Aquatic Ecosystems; (4) Ensure Safe Drinking Water; and (5) Protect Public Safety. For each goal, measurable outcomes (measures of success) are identified. The 2016 TMDL Vision priorities are linked to these goals and measures of success to ensure better engagement and integration with other WRD programs. The 2016 TMDL Vision priorities are summarized below and described more fully along in the TMDL Vision document, available as noted above.

8.3.3.1 Statewide Pathogen TMDL

Michigan has 615 public beaches on the Great Lakes and connecting channels, 602 inland lake beaches, and over 1,400 publicly maintained boat launches making our waters accessible to everyone. Michigan also has over 76,000 miles of rivers, almost 900,000 acres of inland lakes and reservoirs, and over 40,000 square miles of Great Lakes and bays (including Lake St. Clair), all of which are designated for Total Body Contact recreation from May 1 through October 31 and for Partial Body Contact Recreation year-round. Michiganders and EGLE are proud of their beautiful beaches and care about water quality and keeping the people of Michigan and our visitors safe while recreating in Michigan's waters.

EGLE has worked toward achieving its priority goal of clean beaches for recreation through an extensive investment of resources. However, in 2013, the EGLE estimated that 48 percent of the rivers and streams exceed the Total Body Contact Recreation designated use and 20 percent of monitored beaches have had closures due to bacterial pollution (MDEQ, 2014). To help attain the goal of enhancing recreational waters and tie together the efforts that Michigan continues to expend on reducing *E. coli* contamination of surface waters, EGLE made it a priority to develop a pathogen TMDL that addresses all waters impaired by *E. coli*.

This TMDL identifies waters where action is needed, sets an *E. coli* concentration target based on protecting the Total and Partial Body Contact Recreation designated uses, and identifies needed pollutant reductions in all waters that are not meeting these designated uses. The statewide *E. coli* TMDL applies to impaired waters only, including inland lakes, rivers, and streams, beaches, and the Great Lakes.

The statewide *E. coli* TMDL eliminates the need for numerous individual watershed-based *E. coli* TMDLs and the associated repetitive paperwork burden, long wait periods, and staff time spent on TMDL development. A statewide TMDL saves EGLE a significant amount of resources that would have been spent writing watershed-based TMDLs, while providing a faster

path to implementation. For example, we can accelerate water quality restoration through implementation in NPDES permits, particularly MS4 permits, by more than a decade. Interested stakeholders can be assisted with source assessment, monitoring, and restoration solutions in their watershed to provide more site-specific information to enhance TMDL implementation at the local level. In these ways, our statewide *E. coli* TMDL aligns with the purpose of the USEPA's TMDL Vision, which emphasizes a path to better implementation of the Clean Water Act Section 303(d) program, water quality restoration, and coordination of water programs. More information on the statewide *E. coli* TMDL can be accessed at <http://www.Michigan.gov/EcoliTMDL>. To view waters covered by it, select the "*E. coli* monitoring" tab of the *E. coli* Pollution and Solution Mapper.

8.3.3.2 Statewide Mercury TMDL

Reducing human and wildlife exposure of mercury is also a priority in Michigan. The Michigan Department of Community Health continues to issue general fish consumption advisories and guidelines for all inland lakes in Michigan, and specific recommendations for Lakes Huron, Michigan, and Superior, and several hundred miles of rivers and streams due to mercury concentrations in fish tissue. Because of the widespread impairment of Michigan's waters due to mercury, a statewide TMDL approved in 2018 for inland waters primarily impacted by atmospheric deposition of mercury included needed mercury reductions from air sources and water dischargers to protect and restore inland waters.

8.3.3.3 Additional TMDL Activities per Michigan's Vision

In addition to the statewide *E. coli*, Mercury, and PCB TMDLs, the following TMDLs will be submitted for USEPA approval prior to 2022 as part of Michigan's TMDL Vision.

- Grand River/Red Cedar River Dissolved Oxygen TMDL.
- Trap Rock River and Owl Creek Copper TMDLs.
- Cass River watershed *E. coli* TMDLs. (Already public noticed and complete, but not submitted) It is expected that work to reduce *E. coli* will also result in reducing levels of nutrients and sediment entering surface waters, since many best management practices designed to mitigate sources of *E. coli* may also remove other pollutants.)

Michigan's Section 303(d) list, including assessment unit information and TMDL year, is presented in Appendix C.

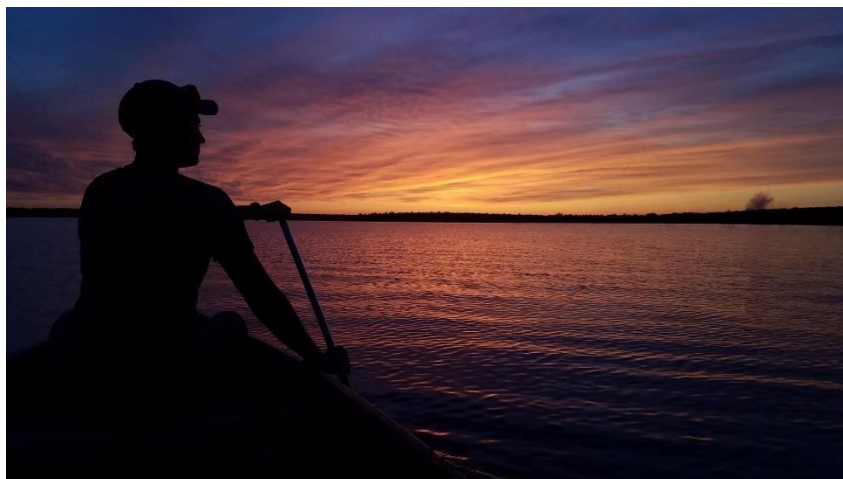
8.3.4 Changes to the Section 303(d) List

The 2020 Section 303(d) list is provided in Appendix C. This list reflects the deletion and addition of assessment units or causes of impairment since the 2018 IR. Section 303(d) delisted assessment units may or may not support designated uses. For example, it may have been determined that the assessment unit is not supporting one or more designated uses but a TMDL is not required, or a cause of impairment may have been removed but a TMDL is still required to address a different cause of impairment. A brief delisting reason is provided in Appendix D1. Deletions and additions to the Section 303(d) list are presented in Appendix D1 and D2, respectively

CHAPTER 9 PUBLIC PARTICIPATION IN THE IR

9.1 Introduction

EGLE provides opportunities for public participation in the development of the IR. The following information is a summary of those opportunities, the comments or information received from the public, and EGLE's response.



9.2 Request for Data

EGLE's, WRD, requested ambient water quality data (chemical, biological, or physical) that were obtained by other governmental agencies, nongovernmental organizations, or the public for Michigan surface waters since January 1, 2017. All water quality data submitted to the EGLE, WRD, before June 21, 2019 was evaluated according to the EGLE's assessment methodology (see Chapter 3) and potentially used to help prepare this IR. This request was published on the EGLE's calendar from May 10 through June 20, 2019, and an e-mail sent via EGLE list-serve to over 1,600 members with specific interest in the Integrated Report and TMDL programs. Data were received from the following organizations: Alliance of Rouge Communities, Delhi Charter Township, Livingston County Drain Commissioner's Office, Little Traverse Bay Bands of Odawa Indians, Platte Lake Improvement Association, Portage, Base, and Whitewood Owners Association, Mid-Michigan District Health Department, Superior Watershed Partnership, USDA Forest Service, USGS, and the Yellow Dog Watershed Preserve. Table 9.1 summarizes whether these outside data were used, if so, how, and, if not, why.

Table 9.1 Summary of outside data received and their use in the 2020 IR.

Organization	Data Used?	How (if Yes or Partial), Why (if No)
Alliance of Rouge Communities	Partial	A; <i>E. coli</i> samples reviewed but not usable; Macroinvertebrate data used to update relevant Assessment Units
Delhi Charter Township	Yes	<i>E. coli</i> data used for assessment decisions
Livingston County Drain Commissioner's Office	No	A; insufficient to calculate TSI
Little Traverse Bay Bands of Odawa Indians	Yes	Data reviewed and used to update relevant Assessment Units
Platte Lake Improvement Association	Yes	Data reviewed and used to update relevant Assessment Units
Portage, Base, and Whitewood Owners Association	Yes	Data reviewed and used to update relevant lake Assessment Units through CLMP program
Mid-Michigan District Health Department	Yes	<i>E. coli</i> data used for assessment decisions

Superior Watershed Partnership	No	C, Data formatting and lack of location information prevented use.
USDA Forest Service	No	C, Additional data discovery needed to assess utility.
USGS	Yes	Data reviewed and used to update relevant Assessment Units
Yellow Dog Watershed Preserve	Yes	Data reviewed and used to update relevant Assessment Units

A. Data did not meet minimum requirements for sample size and/or duration

B. Data for parameters not currently used as assessment indicators

C. Data retrieval and manipulation problems

9.3 Public Notice of Draft Assessment Methodology

A draft version of Chapter 3, the assessment methodology, was made available on EGLE's Web site for public review and comment. This announcement was published on EGLE's calendar on March 21, 2020. Public comments to be considered in the development of Chapter 4 were due April 21, 2020. Three public comments on the draft assessment methodology were received. Additionally, comments on the draft assessment methodology were received from the USEPA; comment summaries and responses are presented below. All comments received are included in their entirety in Appendix E.

Comment #1:

Drain Commissioners in the State of Michigan oversee a vast area of surface water in County drains! As a matter of fact, 90% of the surface water in Monroe County is in manmade drains. This needs to be addressed in the IR. ...This is a resource that cannot be overlooked! The Clean Water Act has been around for a long time and this isn't the first Draft IR. Does this mean that County Drains are exempt? (Richard Micka)

EGLE Response:

From a county drain perspective, regardless of their status as a "drain" these water bodies are still considered surface waters of the state and subject to the same water quality goals and uses as streams that run their natural course. As such, they fall under our surface monitoring programs and are subject to the same expectations and assessments of water quality as natural streams.

Comment #2:

Could this year's Integrated Report, please, include an explanation of how it is that Saginaw Bay, with the Saginaw River, can be designated as a Great Lakes Area of Concern, but not be included on the list of Impaired Waters in the Integrated Report? (Bill Wright, Vice Chair, Partnership for the Saginaw Bay Watershed)

EGLE Response:

We understand the confusion that often arises when looking at the AOC Program's Beneficial Use Impairments (BUIs) and drawing parallels with Designated Uses in the Water Quality Standards. Because of differences in the ways that BUIs were selected in the various AOCs,

there may not be supporting data, or criteria and thresholds to support a similar story under the Clean Water Act WQS program. Some additional description of this issue is inserted in Section 4.7, using Saginaw Bay as an example. While there have not been nutrient-related impairment decisions made for aquatic life-related designated uses, be aware that the WRD is still actively monitoring shoreline areas around the bay with the intention of using that information as part of an anticipated decision process.

Additionally, it is worth noting that the Saginaw Bay is listed for fish consumption, which concurs with the Restrictions on Fish and Wildlife Consumption BUI, and is assessed using beach monitoring E. coli data for total and partial body contact designated uses at beaches, although none are currently listed as impaired, although there is a Beach Closings BUI.

Comment #3:

It is truly bothersome that all our waters are unacceptably PCB contaminated and we are still misplacing our hope in the TDML (*sic*) process. Air transport is within a hemispheric ecosystem. There is no way that applying the TDML (*sic*) approach in a small region will have a significant affect on our waters.

Please pass the ball to the State Department and insist that they negotiate banning in what was once the "developing world," but is now our unregulated supplier of chemicals and manufactured goods. (Melvin J. Visser, retired engineer)

EGLE Response:

We appreciate the concern and perspective on the truly global problem that persistent, bioaccumulative chemicals like PCBs present in our environment. Continued work to address legacy sources within Michigan is important, but you highlight another important process that each citizen who finds this issue important can engage in, letting their elected officials understand their views on this important issue and their potential world-wide impact.

Comment #4:

1. As stated in EPA's previous comments on the State's draft Assessment methodologies, EPA remains concerned that the threshold levels Michigan uses for listing determinations for "Warmwater Fishery and Coldwater Fishery, and Other Indigenous Aquatic Life and Wildlife" are at levels which may not fully identify impairment. MI EGLE has agreed that the current thresholds need to be evaluated. Michigan has been working with EPA and EPA's contractor to evaluate the macroinvertebrate index. This work should be completed in 2020. EPA asks that the State use this new information to develop the 2022 list.
2. Page 4 of the draft Assessment Methodology states: "Michigan uses the principle of independent applicability when making a support determination for each designated use for each water body." However, on page 10, Section 3.5.2.1 "Fish Community," the document states "Data on indicator species absence, while difficult to quantify with ultimate certainty, will be considered in a weight-of-evidence approach from a number of proven sources such as creel data, fish community sampling , . . ." Then, on page 12, Section 3.6.1.2, "Water Column Nutrient Concentrations," the document states: "For inland lakes, various data are useful in a 'weight of evidence' approach" The draft

Assessment Methodology should explain how these statements referencing a weight of evidence approach reflect the principle of “independent applicability,” as EPA policy states.

3. Regarding the “Public Water Supply Designated Use” on pages 25-26 of the draft Assessment Methodology, we recommend that MI EGLE look at the public water supply use assessment methodologies that Ohio (<https://www.epa.ohio.gov/dsw/tmdl/OhioIntegratedReport#123166646-2002>) and WI (<https://dnr.wi.gov/topic/SurfaceWater/Assessments.html>) have developed for cyanotoxins, especially now that MI EGLE has recently begun sampling for cyanotoxins in surface waters used for drinking water. In addition, we recommend that MI EGLE consider updates to the section on “Total Microcystins,” for example by removing the following language:

Although the presence of microcystins in source water may necessitate additional treatment from a SDWA program standpoint, the link between that need and the presence of total microcystins in source water that indicates something unnatural and caused by a pollutant may not be clear in many cases. .

We are unclear what this language means and do not believe it would be appropriate to wait to determine that something is “unnatural and caused by a pollutant” before making an impairment decision based on available water quality data that could help protect public health. (James Ruppel, USEPA)

EGLE Response:

1. *EGLE agrees and anticipates incorporating new macroinvertebrate community scoring and attainment thresholds in the IR process as soon as they are fully developed and incorporated into our Procedure 51 process.*
2. *Additional edits were made in Section 3.3 to distinguish between the independent application of various data sources (which make up the vast majority of our assessment decisions) and the occasions where we use a weight-of-evidence approach. Some particular data types without clear individual thresholds (e.g. often related to narrative criteria) or situations using less standardized data sets may require consideration of multiple parameters used in combination as a ‘weight-of-evidence approach’ to provide a context that evaluation of multiple data types brings.*
3. *Contrary to the comment, EGLE has not started any routine monitoring for microcystins from surface waters used as public water supplies. While recent collaborative work between the WRD and the Drinking Water and Municipal Assistance Divisions have helped provide rapid testing strips for some drinking water facilities to qualitatively test raw intake water periodically, no formal plan exists for WRD to routinely sample surface waters. However, the references provided to other Region 5 state assessment methods is helpful as we continue to evaluate needs for advancement in the Assessment Methodology to support priority concerns and use existing or anticipated available data.*

We will continue to review this portion of the Assessment Methodology in future IR cycles to reflect conservative human health protection with realistically available data. While we continue to retain the specific language in Chapter 3, we have made edits for additional clarity that we expect instances of microcystin data, with no other context, to be a rarity in the assessment process (last paragraph of 3.9.1.5). In any case, the WRD continues to seek out ways to work more closely with the Drinking Water and Municipal

Assistance Division to ensure sharing of surface water monitoring data that may be useful to the Safe Drinking Water Act program in their important role to ensure the availability of safe drinking water.

9.4 Public Notice of the Draft IR

A draft version of this 2020 IR was made available on EGLE's Web site for public review and comment. This announcement was published on EGLE's calendar on June 26, 2020. Public comments to be considered in the development of the final Integrated Report were due July 27, 2020. Two public comments on the draft Integrated Report were received. Comment summaries and responses are presented below. All comments received are included in their entirety in Appendix E.

Comment #1:

Lake Erie

EGLE must clearly describe its plan for addressing the current shortcomings in its collaborative process for addressing nutrient pollution in Lake Erie, as well as its plan for either developing a TMDL or an EPA-approved alternative to a TMDL. Addressing nutrient pollution and the resultant cyanobacteria blooms in Lake Erie is an urgent problem. As such, we urge EGLE to commit to developing a TMDL in this Integrated Report. At the very least, EGLE should commit to working with the EPA to develop a TMDL alternative as well as a schedule for developing a TMDL if the alternative is not effective.

Saginaw Bay

The Integrated Report suggests that nearshore organic matter buildup in Saginaw Bay is due to interactions with, among other factors, exotic mussels, and not necessarily excessive nutrient loading. Similar to the Western Basin of Lake Erie, the impact of nutrient cycling dynamics caused by mussels is often more complex than the Department suggests. We are discouraged that the Department continues to point at mussels while seemingly downplaying the obvious, and well documented, nutrient loading from agriculture in the Basin. Specific to monitoring, what is the Department's timeline to fill data gaps for shoreline and open water monitoring of Saginaw Bay which the report acknowledges is lacking?

(Tom Zimnicki, Program Director, Michigan Environmental Council)

EGLE Response:

We appreciate the comments received from the combined Michigan Environmental Council and the Great Lakes Environmental Law Center. The interest and engagement in the Integrated Report process is important in advancing water quality in Michigan.

Lake Erie

EGLE remains committed to being actively engaged in the binational Annex 4 processes as the most effective means of addressing the widespread nutrient pollution issues and sources affecting Lake Erie. Because this process was well underway when Michigan first listed its portion of Lake Erie as impaired in 2016, and because it is designed at a multi-state and binational scale, it represents a significantly more efficient and effective way to work toward broad reductions in nutrients in the Lake Erie watershed. Similar to a TMDL, the identification of current pollutant loads; development of targets to meet desired goals with necessary concomitant reductions; and the necessity in engaging multiple partners in a collaborative approach to address nonpoint sources of nutrients not currently regulated under either approach

(TMDL or Annex 4) are all important components in the Annex 4-related efforts. As has been recognized and stated in the past, however, if the efforts underway aren't effective in achieving the reductions needed to return the Lake to target conditions, and result in designated use support, Michigan will develop a TMDL to address nutrient pollution as required by the Clean Water Act.

In the interim, in the advance of the 2022 Integrated Report EGLE plans on working with the USEPA to categorize Lake Erie as Impaired, but with an Alternative plan in place (i.e., a Category 5 – Alternative). To our knowledge this will be the first use of the Category 5 – Alternative in our USEPA Region, and we anticipate learning from USEPA staff and other Regions the necessary components to support an Alternative plan that clearly identifies within the IR process the plans in place, schedules, and actions underway toward achieving nutrient load reductions.

Saginaw Bay

We appreciated these comments, as the discussion around invasive mussel impacts to nutrient cycling were primarily intended to provide context for decaying organic matter deposits on shorelines not typically subject to higher nutrient concentrations. As such, we've edited the text in Section 4.7 to better reflect that intent.

With regard to Saginaw Bay, we anticipate being able to use the information gathered from recent shoreline monitoring to allow us to revisit assessments related to shoreline conditions during the 2022 IR period, which will include the development of relevant assessment methodology to aid in that process. Concerning the open water portion of Saginaw Bay and nutrient expression, EGLE anticipates using NOAA satellite imagery analysis as a critical component in determining impacts of algae blooms on a broad scale, similar to its utility in assessing Michigan portions of Lake Erie in the 2016 IR cycle.

Comment #2:

We strongly support the Water Resources Division plan to identify meaningful and measurable environmental outcomes that will guide a program of wetland protection and restoration. This would be very useful to the efforts of Healthy Pine River (healthypineriver.org). The Upper Pine River Watershed Management Plan, December 2019, EGLE Tracking code: 2017-0102, "Figure 10.2 Priority Wetland Restoration Sites", identifies a significant land area that, if even partially restored to wetlands, would reduce the agricultural runoff burden in our watershed. Knowing how much a wetland restoration can help restore the health of the Pine River could be an important addition to conservation easements in persuading property owners to participate. (David Shepherd, Healthy Pine River)

EGLE Response:

Thank you for your interest and engagement in wetland protection and restoration. Your comments have been forwarded to our wetlands program staff to make them aware of Healthy Pine River's concern and suggestion.

Literature Cited

- Bridgeman, T.B. and W.A. Penamon. 2010. Lyngbya Wollei in Western Lake Erie. *Journal of Great Lakes Research*. 36:167-171.
- Carvalho, L., C. McDonald, C. de Hoyos, U. Mischke, G. Phillips, G. Boricks, S. Poikane, B. Skelbred, A.L. Solheim, J. Van Wichelen, and A.C. Cardoso. 2013. Sustaining recreational quality of European lakes: minimizing the health risks from algal blooms through phosphorus control. *Journal of Applied Ecology*. 50. 315-323.
- Comer, P. 1996. Wetland Trends in Michigan Since 1800: a Preliminary Assessment. Report to USEPA and DEQ-LWMD. Submitted 1996. 76 pp.
- Creal, W., S. Hanshue, S. Kosek, M. Oemke, and M. Walterhouse. 1996. Update of GLEAS Procedure 51 Metric Scoring and Interpretation. DNRE Report #MI/DEQ/SWQ-96/068. Revised May 1998.
- EGLE. 2019a. Water Quality and Pollution Control in Michigan 2018 Sections 303(d), 305(b), and 314 Integrated Report. EGLE Staff Report #MI/DEQ/WRD-19/001.
- EGLE. 2019b. Michigan's Water Chemistry Monitoring Program. A Report of Statewide Patterns 2005-2014 and Fixed Station Status and Trends 1998-2014. MI/EGLE/WRD-19/015.
- Fuller, L.M. and C.K. Taricska. 2012. Water-Quality Characteristics of Michigan's Inland Lakes, 2001-10. USGS Scientific Investigations Report 2011-5233, 53 pp.
- Harris, V. 2004. *Cladophora* Confounds Coastal Communities – Public Perceptions and Management Dilemmas. Proceedings from the *Cladophora* Research and Management in the Great Lakes workshop, University of Wisconsin-Milwaukee. December 8, 2004.
- Hecky, R.E., R.E.H. Smith, D.R. Barton, S.J. Guildford, W.D. Taylor, M.N. Charlton, and T. Howell. 2004. The Nearshore Phosphorus Shunt: A Consequence of Ecosystem Engineering by Dreissenids in the Laurentian Great Lakes. *Can. J. Fish, Aquat. Sci.* 61(7):1285-1293.
- International Association for Great Lakes Research. 2002. Research and Management Priorities for Aquatic Invasive Species in the Great Lakes. 22 pp.
- Jones, R. and K. Gerard. 1999. Reference Site Sediment Chemistry Report for Wadable Streams, 1994, 1997 and 1998. March 1999. MDEQ Report No. MI/DEQ/SWQ-99/060.
- MacDonald, D. C. Ingersoll and T. Berger. 2000. Development and Evaluation of Consensus Based Sediment Quality Guidelines for Freshwater Ecosystems. *Arch. Environ. Contam. Toxicol.* 39, 20-31.
- MDEQ. 1990. SWAS Procedure WRD-SWAS-051. Qualitative Biological and Habitat Survey Protocols for Wadable Streams and Rivers, April 24, 1990. Revised June 1991, August 1996, January 1997, May 2002, and December 2008. Reformatted May 2014. http://www.michigan.gov/documents/deq/wb-sw-as-procedure51_280711_7.pdf.

- MDEQ. 1997. A Strategic Environmental Quality Monitoring Program for Michigan's Surface Waters. January 1997. Report #MI/DEQ/SWQ-96/152.
- MDEQ. 2005. MDEQ Quality Management Plan (QMP). December 2, 2005. Revised July, 2008.
- MDEQ. 2007. Quality Assurance Planning for Environmental Data Collection Activities Policy and Procedure #WB-008. May 21, 2007.
- MDEQ 2013a. Michigan Inland Lake Project: Identification, Survey and Classification. #MI/DEQ/WRD-13/024.
- MDEQ. 2013b. Qualitative Biological and Habitat Survey Protocols for Nonwadeable Rivers. Policy and Procedure #WRD-SWAS-022.
- MDEQ. 2014. Michigan Beach Monitoring Year 2013 Annual Report. Report #MI/DEQ/WRD-14/025.
- MDEQ. 2015. Biological Monitoring Status and Trend Procedure. Policy and Procedure #WRD-SWAS-027. August 4, 2015.
- MDEQ. 2017. Michigan Surface Water Monitoring Strategy Update 2017. January 2017. Report #MI/DEQ/WRD-16/004. https://www.michigan.gov/documents/deq/wrd-swas-strategy-2017_556101_7.pdf
- Omernik, J. and A. Gallant. 1988. Ecoregions of the Upper Midwest States. USEPA, Envir. Res. Lab. Publication #EPA/600/3-88/037.
- Ontario Ministry of the Environment. 1993. Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. Prepared by: D. Persaud, R. Jaagumagi, and A. Hayton. Water Res. Br. OME. ISBN 0-7729-92-48-7.
- Sommers, L.M. (ed). 1977. Atlas of Michigan. Michigan State University Press.
- Soranno, P.A., K.S. Cheruvilil, R.J. Stevenson, S.L. Rollins, S.W. Holden, S. Heaton, E. Torng. 2008. A framework for developing ecosystem-specific nutrient criteria: Integrating biological thresholds with predictive modeling. Limnology and Oceanography, 53(2):773-787.
- Strum, M. 2000. Total Great Lakes Area and Michigan's Jurisdictional Area. Army Corps. of Engineers, Detroit Office, Great Lakes Hydraulics & Hydrology Unit.
- USEPA. 1999. 1999 Updated of Ambient Water Quality Criteria for Ammonia. Office of Water. EPA-822-R-99-014.
- USEPA. 2000. Methods for Measuring Toxicity and Bioaccumulation of Sediment-Associate Contaminants and Freshwater Invertebrates; Second Edition. Office of Research and Development, Mid-Continent Ecology Division. EPA/600/R-99-064. March 2000.

- USEPA. 2001. Water Quality Criterion for the Protection of Human Health: Methylmercury. Office of Science and Technology, Office of Water. EPA-823-R-01-001.
- USEPA. 2002. Consolidated Assessment and Listing Methodology: Toward a Compendium of Best Practices. Office of Wetlands, Oceans and Watersheds. July 2002.
- USEPA. 2006. Application of Elements of a State Water Monitoring and Assessment Program for Wetlands. Wetlands Division, Office of Wetlands, Oceans and Watersheds. April 2006.
- USEPA. 2011. Saginaw River and Bay Area of Concern. October 5, 2011.
<http://www.epa.gov/glnpo/aoc/sagrivr.html>
- USEPA. 2015. Great Lakes National Program Office Environmental Indicators, Trophic State of the Great Lakes. October 23, 2015.
(The link provided was broken and has been removed)
- Waples, J. T., and J. V. Klump. 2002. Biophysical Effects of a Decadal Shift in Summer Wind Direction over the Laurentian Great Lakes, Geophys. Res. Lett., 29(8), 1201, doi:10.1029/2001GL014.
- Watson, S., E. McCauley, and J. Downing. 1992. Sigmoid Relationships between Phosphorus, Algal Biomass, and Algal Community Structure. Canadian Journal of Fisheries and Aquatic Science. 49: 2605-2610.